

Woodruff Residential Center

Boiler Replacement

SITE LOCATION



100% CONSTRUCTION DOCUMENTS 12-8-2021



SG Project 21290EMOWDR





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Section 01 11 00 - Summary of Work Requirements

General

This section of the project manual is to be dedicated to a detailed narrative of the summary of the work. This narrative must include a description of the scope of the work for each designer and consultant as well as the Owner and the Owner's consultants and contractors. The design intent and parameters of each building system must be defined with the definitions using as much quantitative information as possible. Documentation of Owner and user knowledge and understanding of the design intent and the completed facility's performance expectations must be explained. Facility programming reports and the translation of these reports into design parameters shall also be included in this specification section.

This section of the specification shall be organized in such a fashion that all expectations of the performance of the building can be easily obtained and referenced during the commissioning and occupation of the facility. Generic descriptions, references to industry or local standards, or weakly defined design intent are not acceptable for this section or for contract performance at Emory University.

Specific Requirements

Project Title - Each project will be given an official title and Building ID for use during the duration of the project. The project title shall appear on all documents related to the Project. Emory may, at any time, revise the project title and require all documents to be revised accordingly.

Legal Description - Legal descriptions shall appear in every complete set of drawings. The background for the legal description can be obtained from the archives of Campus Services CSIT.

Street Addresses - Street addresses for projects are assigned by the Jurisdiction Having Authority.

Describe the conditions for partial occupancy, if any will be permitted or required. Identify the extent of the Owner's on-site operations, if the Owner intends to continue these during construction.

Appropriate topics for Summary of Work include:

- 1. Work covered by Contract Documents
- 2. Contracts
- 3. Work under other contracts
- 4. Future work
- 5. Work sequence
- 6. Contractor use of premises
- 7. Occupancy requirements: Owner occupancy; Partial occupancy; Continued occupancy; and, Maintenance of operation
- 8. Products ordered in advance
- 9. Owner furnished products
- 10. BIM Execution Plan

Building Information Modeling (BIM) Guidelines & Standards

The Building Information Modeling (BIM) program is implemented at Emory University to achieve excellence in the design, construction and management of facilities at Emory. The BIM Execution Plan (BEP), prepared by the AE and the CM/GC, is the core of the work plan for programming, designing, evaluating, constructing and operating our facilities. The BIM modeling process and the database that is developed through the BEP, fosters open and shared collaboration among the AE, the CM/GC and Campus Services and coordinated, consistent and accurate information to be used by all over the useful life of the building.



the current procedures. The pre-construction meeting should be scheduled with the Project Manager. The Emory University Director of Fire Safety shall attend.

Outage Requests

All necessary service interruptions of utilities of any type or magnitude shall be scheduled in advance with Emory University's Project Manager.

Pre-Installation Conferences

The Contractor shall conduct a pre-installation conference at the site before each construction activity that requires coordination with other construction. Installers and representatives of manufacturers and fabricators involved in or affected by the installation, and its coordination or integration with other materials and installations that have preceded or will follow, shall attend the meeting.

OAC Meetings

Owner, Architect and Construction Manager team meetings will be arranged by the Construction Manager and scheduled for at least every two weeks (or as approved by the Emory's Project Manager). The Emory's Project Manager, the Architect, and Contractor shall attend the OAC Meetings and other appropriate persons familiar with the project and authorized to conclude matters relating to the Work, as agreed.

- 1. These meetings shall not reduce the Contractor's responsibility for and control over, as expressed in the contract, construction means, methods, etc. and for coordinating all portions of the Work.
- 2. Coordinate meetings to review Applications for Payment with weekly scheduled meetings. This will facilitate more timely reviews of Applications for Payment.
- 3. The Construction Manager is responsible for documentation of meeting minutes.
- 4. The Progress Drawings (as-builts) will be reviewed at each OAC meeting for completeness and thoroughness. Applications of payment will not be approved unless Progress Drawings (as-builts) are current for the month.

Other Meetings

Additional specific construction meetings may also be held for other purposes, such as critical design, performance or coordination issues, and the like. The Construction Manager will be responsible for documentation and distribution of meeting minutes.



Section 01 32 00 – BIM Guidelines – Scope, Deliverables and Progress

Establish the Program (Emory)

The Program Manager, if used on the project, is selected by the Owner typically through a Request for Proposal (RFP) process at the beginning of the project. The Owner may also choose to take the role of the Program Manager and not use a separate Program Manager. In such a case, the Owner shall fill the role of the PM throughout the Project. The Program Manager and the Owner establish the Building Space Program, the Construction Cost Model (Estimate) Guaranteed Maximum Price (GMP) Budget and the Schedule (with Milestones) for the Project.

An Overview of BIM Deliverables by Phase

These BIM Deliverables, along with the BIM Execution Plan (BEP), supplement the deliverables by phase required by Emory University for the specific Project.

BIM Deliverables - Pre-Design Phase

BIM deliverables in the Pre-Design Phase include mass models of building and site based on the program and budget. Narratives are produced by the AE describing architectural, structural and MEP systems. Early cost models and schedules are created for project planning. The format for the BIM model during the Pre-Design phase is determined by the AE and Emory, unless the CM/GC is engaged in the Project, and in such cases, the format for the BIM model is determined by the BEP, prepared by the AE and the CM/GC and submitted for review and approval by Campus Services.

Targets for sustainable design resources for land, materials, energy and water are defined. Detailed requirements of the topographic survey are provided by the Owner.

Existing and new utilities within the Project boundary to within five (5) feet of the building are indicated, to include storm sewer, sanitary sewer, water lines, main irrigation, gas, electrical and communications.

Various design strategies with preliminary cost estimates and schedules are provided. Goals for sustainable design strategies for resources of land, materials, energy and water are defined. Specific LEED program and goals are defined.

BIM Deliverables - Schematic Design Phase

(Note: These BIM Deliverables supplement the Campus Services "Document Delivery Standards".)

Level of Development 100 as defined by AIA Document G202 - 2013

Validate the Program Requirements

The Design Team shall validate the Program requirements for the Project including the space use and the performance requirements. The BIM model shall be used to calculate and indicate assignable area and non-assignable area for each space and overall net and gross area of the building.

Establishing the Construction Cost Model (Estimate) or Guaranteed Maximum Price (GMP)

In accordance with the BEP plan, the CM/GC prepares a complete Schematic Design Construction Cost Model (Estimate) or GMP as required by the AE and GM/GC agreements and the BEP.

Schedule and Project Milestones

During Schematic Design, the CM/GC provides updated (or reconfirmed) construction schedules per the BEP.



Interference Checking

During Schematic Design, Interference Checking using a model or method as determined by the BEP plan established for the Project.

Energy Goals and Modeling

The Schematic Design shall address energy, water, building envelope and HVAC for the Project as a part of the BEP plan established for the Project or as modified by the Emory Project Manager. Local gas and electric rates, including peak demand premiums shall be obtained from the Emory Project Manager **BIM Green Building Goals and Modeling**

Sustainability and LEED goals, established in the "Design and Construction Standards" or as modified by the Emory Project Manager and as described in the BEP for the Project, are incorporated in Schematic Design.

Quality Control

Standards of quality, established in the "Design and Construction Standards" and in the Schematic Design used in establishing the Construction Cost Model (Estimate) or GMP, are addressed in Schematic Design.

BIM Asset Information Database (BIM-AID)

During Schematic Design, the BIM Asset Information Database (BIM-AID) begins and is populated by the Design Professionals with attributes (data) from the BIM model. Attributes are added and revised in the BIM categories established in the BEP as the BIM model evolves.

BIM Deliverables - Design Development Phase

(Note: These BIM Deliverables supplement the Campus Services "Document Delivery Standards".)

Level of Development 200 as defined by AIA Document G202 - 2013

Revalidate the Program Requirements

The Design Team shall revalidate the Program requirements for the Project including the space use and the performance requirements. The BIM model shall be used to calculate and indicate assignable area and non-assignable area for each space and overall net and gross area of the building.

Reconfirm the Construction Cost Model (Estimate) or Guaranteed Maximum Price (GMP)

In accordance with the BEP plan, the CM/GC provides a complete Design Development Construction Cost Model (Estimate) or GMP as required by the AE and the CM/GC agreements and the BEP.

Schedule and Project Milestones

During Design Development, the CM/GC provides updated (or reconfirmed) construction schedules per the BEP.

Interference Checking

During Design Development, Interference Checking using a model or method as determined by the BEP plan established for the Project.

Energy Goals and Modeling

The Design Development phase shall address energy, water, building envelope and HVAC for the Project as a part of the BEP plan established for the Project or as modified by the Emory Project Manager. Local gas and electric rates, including peak demand premiums shall be obtained the Emory Project Manager **BIM Green Building Goals and Modeling**



Sustainability and LEED goals, established in the "Design and Construction Standards" or as modified by the Emory Project Manager and as described in the BEP for the Project, are incorporated into the Design Development model.

Quality Control

Standards of quality, established in the "Design and Construction Standards" and in the Schematic Design used in establishing the Construction Cost Model (Estimate) or GMP, are addressed in Design Development.

BIM Asset Information Database (BIM-AID)

During Design Development, the BIM Asset Information Database (BIM-AID) continues and is populated by the Design Professionals with attributes (data) from the BIM model. Attributes are added and revised in the BIM categories established in the BEP as the BIM model evolves.

BIM Deliverables - Construction Documents Phase

(Note: These BIM Deliverables supplement the Campus Services "Document Delivery Standards".)

Level of Development 300 as defined by AIA Document G202 - 2013

Revalidate the Program Requirements

During the Construction Documents phase, the Design Team shall revalidate the Program requirements for the Project including the space use and the performance requirements. The BIM model shall be used to calculate and indicate assignable area and non-assignable area for each space and overall net and gross area of the building.

Reconfirm the Construction Cost Model or Guaranteed Maximum Price (GMP)

In accordance with the BEP plan, the CM/GC confirms the Construction Documents Construction Cost Model or Guaranteed Maximum Price (GMP) as required by the AE and CM/GC agreements and the BEP based on bids from subs and suppliers of elements, assemblies and systems. The General Contractor shall provide a complete Schedule of Values for Construction and reconfirm the Construction Cost Model or the GMP before completion of this phase. The Schedule of Values for Construction shall be used as the basis of monthly pay requests during the Construction phase.

Reconfirm Schedule and Project Milestones

During Construction Documents, the CM/GC provides final construction schedule per the BEP. The CM/GC addresses construction sequencing of specific detailed elements. The "CM/GC Construction BIM Model" schedule is to show time scaled elements of specific assemblies and systems of the construction of the building, including means and methods of construction in accordance with the BEP.

Interference Checking

During Construction Documents, Interference Checking using a model or method as determined by the BEP plan established for the Project.

Energy Goals and Modeling

Satisfy goals for energy, water, building envelope and HVAC design for the Project as a part of the BEP plan established for the Project or as modified by the Emory Project Manager.

BIM Green Building Goals and Modeling

Satisfy the Sustainability and LEED goals established in the "Design and Construction Standards" or as modified by the Emory Project Manager and as described in the BEP for the Project. Incorporate the design in the Construction Documents BIM model.



Quality Control

Standards of quality, established in the "Design and Construction Standards" and in the Schematic Design used in establishing Construction Cost Model or the GMP, are included in the Construction Documents.

BIM Asset Information Database (BIM-AID)

During the Construction Documents phase, the AE portion of the BIM Asset Information Database (BIM-AID) is completed by the AE and handed off to the CM/GC. Attributes are added and revised in the BIM-AID by the CM/GC in the BIM categories established in the BEP as the BIM model evolves through the Construction Phase.

BIM Model Transition - the AE Design BIM Model becomes the CM/GC Construction BIM Model

At completion of the Construction Documents phase, the AE Design Team shall provide the Owner and the CM/GC with copies of the "AE Design BIM Model", a complete set of the Construction Documents in the authorized authoring software in accordance with the BEP and the Campus Services "Document Delivery Standards". The Design Team shall also provide a complete set of Bid Documents displaying each sheet of drawings in PDF format and a complete set of Specifications in MS Word and in PDF formats, plus any addenda files, in accordance with the BEP and the Campus Services "Document Delivery Standards".

BIM Deliverables - Construction Phase

(Note: These BIM Deliverables supplement the Campus Services "Document Delivery Standards".)

Level of Development 400 as defined by AIA Document G202 - 2013

In the Construction Phase, the CM/GC shall maintain and keep current the "CM/GC Construction BIM Model" as Progress Drawings and shall make "as-built" notations to the "CM/GC Construction BIM Model". The AE Design Team shall update and maintain concurrently, but separately, the "AE Design BIM As-Built Model" at LOD 300 as official and authorized Construction Change Directives are issued and as work is completed.

The CM/GC may use the "CM/GC Construction BIM Model" for the preparation of shop drawings or as determined by the BEP. The CM/GC shall also maintain and update the "CM/GC Construction BIM Model" with authorized Construction Change Directives as they are issued. The CM/GC shall also update the "CM/GC Construction BIM Model" at LOD 400 with as-built conditions as they occur and transmit those changes to the AE. Monthly reports prepared by the CM/GC shall be logged, posted and distributed to the Project Team in accordance with the BEP.

Should the CM/GC fall behind on the approved Construction Schedule, the CM/GC shall immediately provide a makeup schedule to place the Project back on the original Construction Schedule.

Coordination Meetings During Construction

The CM/GC shall conduct coordination meetings for the construction period in accordance with the BEP or as directed by the Emory Project Manager. The CM/GC shall provide concurrent "as-built" documentation in the "CM/GC Construction BIM Model" throughout construction.

The CM/GC shall conduct Interference Checks at critical milestones in accordance with the BEP. Interference Checks are to be reported and resolved at the coordination meetings. The reported Interference Checks and resolutions shall be logged, posted and distributed to the Project Team in accordance with the BEP.



Building commissioning operations data and performance criteria, including LEED compliance and certifications are to be linked to the CM/GC Construction BIM Model and the AE As-Built BIM Model and other data as described in the BEP as commissioning occurs throughout the Project. It shall be the contractor's responsibility to coordinate the information sources and integrate this information into the CM/GC Construction BIM Model for transfer to the AE for the AE As-Built BIM Model at the completion of the Project.

BIM Deliverables - Closeout Phase

(Note: These BIM Deliverables supplement the Campus Services "Document Delivery Standards".) Level of Development 500 as defined by AIA Document G202 - 2013

During construction, the contractor and subcontractors are to mark up the Construction Documents to show "as-built" conditions. These marked up drawings, the Progress Documents, are sent by the CM/GC to the AE at closeout. The AE then prepares the Record Documents, the final version of the Construction Documents, reflecting "as-built" conditions. Upon completion, the Record Documents (the As-Built BIM Model) for the Project, in accordance with the Emory University Campus Services "Design and Construction Standards" and the "Document Delivery Standards" and the BEP plan for the Project, and within ninety (90) days of Substantial Completions, is delivered to the Owner in the Original Authoring Software and in Autodesk AutoCAD software in accordance with the Campus Services Document Delivery Standards.

Following these guidelines, provide six (6) complete progress documents: one (1) hard copy and five (5) electronic copies on CD's and/or DVD's. One copy is to be kept in the building, Zone library, and HVAC Shop. Additional sets will be kept in the Planning, Design and Construction project files as well as the campus services information management archives. Additional copies are to be requested as needed. Electronic copies of as built drawings are also to be provided in accordance with the computer aided design requirements (CAD) design requirements manual, which is included as a contract attachment. Additionally, a marked-up set of progress document control drawings will be submitted to Emory Facilities Management Control Shop. These prints will be used for trouble-shooting until the completed final Progress Documents are received.

BIM Data at Closeout – The BIM Asset Information Database (BIM-AID)

Upon completion of the construction of the Project, and within ninety (90) days thereafter, and in accordance with the BEP, the AE and the CM/GC will complete and deliver the BIM Asset Information Database (BIM-AID) to the Owner. The BIM-AID spreadsheet database of key building components, systems and assemblies of the Project follows the Emory University BIM-AID Template and is organized in BIM categories containing attributes (data) of essential information for long term operation, maintenance and service of the Project.

Certain cells within the spreadsheet shall accommodate URL's with links to warranty information, shop drawings and other data. The BIM-AID spreadsheet data shall be capable of being mapped by the Owner directly into the facilities management program currently in use by Campus Services, AIM by Asset Works. The Unique Identifiers and the asset names on the spreadsheet shall be tied together. The BIM model drawings may also accommodate hyperlinks to the database for quick and easy access to data either within the BIM model or to other data outside the BIM model in the 2D drawing sets.



LOD by PHASE & DISCIPLINE																
	Design						Construction					Commissioning	Facility Management O&M			
	Schematic Design Design Construction Documents			Pre	Construction			Post Construction	Owner Occupied							
	2D Design	3D 0	Design	3D Coordination									Systems			
	Programming						COBie	3D	3D	Model-Based	Detailing	AS-Built	COBie	Testing	Spatial	Asset
Discipline	&	Massing	Advanced	DD	50% CD	100% CD	Design	Coordination	Virtual	Estimating &	Shop Dwgs	Record	Field	Commissiong	Planning	Tracking &
	Performance		SD				Data		Mockups	Procurement	Fabrication	Modeling	Data	& Handover		Maintenance
	Specs															
ARCH	LOD 50	LOD 100	LOD 150	LO D 200	LOD 250	LOD 300	LOD 300	LOD 300								
MEP-FP	LOD 50	LOD 100	LOD 150	LO D 200	LOD 250	LOD 300	LOD 300	LOD 300								
STRUCT	LOD 50	LOD 100	LOD 150	LO D 200	LOD 250	LOD 300	LOD 300	LOD 300								
CIVIL	LOD 50	LOD 100	LOD 150	LO D 200	LOD 250	LOD 300	LOD 300	LOD 300								
GC								LOD 300	LOD 350	LOD 350	LOD 400	LOD 450	LOD 500			
Cx														LO D 500		
OWNER															LOD 550	LOD 600
* This table	* This table depicts the intent of BIM project lifecyde: utilizing one set of models thru mapping LOD by phase and discipline.															



Section 01 33 23 - Submittals, Shop Drawings, and Product Data

General

Contractor shall provide a schedule of all required submittals. Emory's Project Manager will review this schedule and indicate which of the submittals are to be reviewed by Emory concurrently with the design team. The contractor should convert this submittal schedule into a submittal log. This log shall be reviewed at each Construction Meeting.

Substitutions

Submittals involving Substitution Requests or other modifications requiring review by the Owner shall be sent to the Architect at least 30 calendar days before the date each is required for fabrication or installation. Fabrication or installation cannot start without approved submittals. If the Contractor does not correctly follow this process and construction delays are incurred, the Contractor will be responsible for the schedule impact.

FM Global

FM Global provides loss prevention consulting for Emory and should be involved in the review of all plans. General construction drawings and specifications should be submitted for review at the various stages of progress to include preliminary drawings, as well as final engineering design drawings. All sections should be submitted to include Civil/Utility, Architectural, Structural, Mechanical, Plumbing/Fire Protection and Electrical as well as the specification manual In addition to general construction drawings, any shop drawings and/or vendor generated package system drawings and specifications should be submitted. The following are examples of additional drawings that should be submitted to FM Global for review, if not included with the General Construction drawings.

- 1. Fire protection shop drawings to include hydraulic calculations and manufacturers cut sheets on materials to be used and any fire pump layout piping and equipment specification sheets to include an electrical one line diagram.
- 2. A complete roof cover system package submittal with a "Contractor's Application for Roof Acceptance" Form showing all the components, materials, and securement method details to be used for the roof system and flashing.
- 3. Any integrated exterior finishing systems showing all the components, materials, and securement to be used.
- 4. A complete set of manufacturers design drawings for any pre-engineered all metal building systems.
- 5. Equipment submittals on any gas fired heating equipment such a boilers with a "Manufacturer's Application for Acceptance".
- 6. Any special protection systems such as fixed gaseous systems with an Application for Acceptance" form.
- 7. Any fire protection monitoring and general fire alarm system drawings

Equipment Submittal / Shop Drawing Review Process

Engineering Services (ES) and Emory's third party commissioning consultant (CxA) shall be copied on construction phase equipment and shop drawing submittals when the submittals are sent to the design team for review. This review generally includes Division 14, 21, 22, 23,26, 27, 28 and 33 section submittals. ES and CxA comments will be routed to the design team. The design team will prepare the final list of comments to distribute back to the construction team. The design team will inform ES and the CxA as to how their respective comments were incorporated.

Project specifications shall require all deviations be noted on a submittal transmittal sheet or cover letter. Project specifications shall also require that a line-by-line specification compliance be provided with each submittal applicable to the equipment or system being submitted. Project specifications shall state that



failure of the subcontractor or its supplying manufacturer to state deviations or provide line-by-line specification compliance will be returned "revise and resubmit" without review by the design team, ES or the CxA. Project Specifications shall require that all submittals be reviewied and stamped "approved" by the GC or CM prior to submission to the A/E and Owner.

Suppliers of major equipment such as chillers and boilers shall also provide a letter stating that they have reviewed and understand the design control intent of the equipment and certify that their equipment will function according to the design intent, and if not, request deviation to the intended control.



Section 01 41 00 - Standard of Quality and Regulatory Requirements

Standard of Quality

The Designers and Contractors involved in any project at Emory University shall meet or exceed the written standards of quality as established by appropriate construction and industry organizations. In the event that a similar standard varies from another, the Designer and the Contractor shall meet the more stringent criteria for quality.

Codes and Regulations

All Designers involved in any project at Emory University shall be aware of and design facilities to meet and comply with the minimum requirements of all applicable environmental and building codes, ordinances and standards, at all levels of jurisdiction. All Contractors involved in any project at Emory University shall perform construction work to meet or exceed the minimum requirements of all applicable environmental and building codes, ordinances and standards. Deviations must be agreed to in writing by the regulatory agency and the appropriate representative of Emory University. If a conflict arises between program requirements and codes and ordinances, such conflict must be resolved to the satisfaction of all interested parties prior to completion of the Design Development phase.

Universal Design

It is the policy of Emory University to ensure that no individual shall be discriminated against on the basis of disability in the full and equal enjoyment of all goods, services, facilities, privileges, advantages and accommodations. To that end, Emory University requires that all parties contracting with the University observe all pertinent laws and codes, including but not limited to The Rehabilitation Act of 1973, the Americans with Disabilities Act, the Georgia Accessibility Code, the Fair Housing Administration Act, and any applicable local building or professional codes.

In addition, Emory University is committed to Universal design as a general policy. At Emory, design orientation directs that, to the fullest extent possible, the construction of places, things and information be usable by the widest range of people operating in the widest range of situations without special or separate design.

All drawings and details that pertain to building, life safety and accessibility code compliance:

- Parking associated with project when applicable to include slopes, cross slopes and dimensions.
 Accessible route.
- 3. Accessible entrances to include placement of any power door openers and/or applicable card readers, along with associated accessible routes to door openers and card readers to doors. Drawings should include plans and elevations with dimensions.
- 4. Accessible features in buildings to include drawings of drinking fountains, restrooms, accessible seating in seminar rooms, break rooms, kitchens, locker rooms, shower facilities, etc. Drawings should include plans and elevations with dimensions.
- 5. Placement of any wall switches, outlets, thermostats, etc. as applicable.
- 6. Signage and any alarms.

Sustainability

Emory University maintains a strong commitment to the environment and conserving natural resources. All facility assessments, facility programming and building design shall assess sustainable strategies that could be applicable to a project and incorporate such features into the project as approved by Emory University. Refer to section 01 81 13 Sustainable Design Requirements for additional information.



- *Materials Ingredients* under the current LEED rating system for this material. Masonry materials and products should be extracted, recovered and manufactured within 100 miles of Emory University, where possible. All masonry grouts, cements, and epoxies installed inside the building's weather-vapor barrier must comply with VOC content and emissions criteria in the current LEED rating system.



Section 07 20 00 - Thermal Protection

Scope of Work

This Section includes building wall, floor and ceiling insulation.

Quality Assurance

For all new construction projects and renovation projects that modify the exterior envelope of a building, the Architect must submit documents and energy analysis that verifies compliance of the project with the State Energy Code. All insulation products and/or systems are to be FM Global approved.

Products

- All insulation products shall be specified to meet the maximum flame spread, maximum smoke spread and combustion criteria of the NFPA Codes and ASTM standards.
- Expanded polystyrene board insulation may not be used.
- Polyisocyanurate insulation is FM Global's preferred product to be used under clay tile and low slope roofs.
- Batt insulation shall be formaldehyde free and preferably Greenguard Certified (greenguard.com) or meet the general emissions criteria outlined in the latest LEED rating system.

Performance

In addition to compliance with the State Energy Code, construction assemblies must have the following minimum R-values:

- 1. Walls: 19
- 2. Built Up Roof: 20 above the deck
- 3. Attic Ceiling: 38
- 4. Exposed Floors: 19

07 2419-1

SECTION 07 2419 - WATER-DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)

PART 1 - GENERAL

- 1.1 SUMMARY
 - A. Furnish and install Polymer-Based EIFS and all accessories shown on the Drawings.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Only manufacturers who provide all of the following are acceptable suppliers for this project.
 - 1 Successful EIFS performance history over at least 10 years in the geographical area.
 - 2. Full-scale fire test reports and documentation of ICC Acceptance
- B. Applicator's Qualifications: Only applicators who provide documented license, bonded, and insured.
 - 1. 3-year minimum workmanship warranty on workmanship.
- C. Inspections: Provide period inspection by a principal of the installing firm.
- D. Substrate Protection:
 - 1. Protect exterior gypsum board, plywood, and other moisture sensitive substrate materials from expo sure to adverse weather.
 - 2. Contractor's responsibility to ensure that no water is allowed ingress or trapped behind or within the EIFS.

1.3 PERFORMANCE REQUIREMENTS

- A. EIFS Performance: Comply with the following:
 - 1. Bond Integrity: Free from bond failure within EIFS components or between system and supporting wall construction, resulting from exposure to fire, wind loads, weather, or other in-service conditions.
 - 2. Weathertightness: Resistant to water penetration from exterior into water-drainage EIFS and assemblies behind it or through them into interior of building that results in deterioration of thermal-insulating effectiveness or other degradation of EIFS and assemblies behind it, including substrates, supporting wall construction, and interior finish, and including a means that allows water entering into an EIFS assembly to drain to the exterior.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer's: Subject to the requirements of this section:
 - 1. Sto Corp: Stotherm Essence.
 - 2. Master Builders Solutions
 - 3. Parex USA.
 - 4. Master Wall

2.2 MATERIALS

- A. Air & Moisture barrier
- B. Molded, Rigid Cellular Polystyrene Board Insulation:
- C. High-Impact Reinforcing Mesh:
- D. Finish-Coat Materials: EIFS manufacturer's standard acrylic-based coating
 1. Colors: As selected by Architect from manufacturer's full range.

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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 EIFS.
- B. Examine roof edges, wall framing, flashings, openings, substrates, and junctures at other construction for suitable conditions where EIFS will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Begin coating application only after surfaces are dry.
 - 2. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

- A. Protect contiguous work from moisture deterioration and soiling caused by application of EIFS. Provide temporary covering and other protection needed to prevent spattering of exterior finish coats on other work.
- B. Protect EIFS, substrates, and wall construction behind them from inclement weather during installation. Prevent penetration of moisture behind drainage plane of EIFS and deterioration of substrates.
- C. Prepare and clean substrates to comply with EIFS manufacturer's written instructions to obtain optimum bond between substrate and adhesive for insulation.

3.3 EIFS INSTALLATION, GENERAL

- A. Comply with EIFS manufacturer's written instructions for installation of EIFS as applicable to each type of substrate indicated.
- B. Water-Resistive Coatings: Apply over substrates to protect substrates from degradation and to provide water-/weather-resistive barrier.
 - 1. Tape and seal joints, exposed edges, terminations, and inside and outside corners of sheathing unless otherwise indicated by EIFS manufacturer's written instructions.
- C. Flexible-Membrane Flashing: Install over weather-resistive barrier, applied and lapped to shed water; seal at openings, penetrations, terminations, and where indicated by EIFS manufacturer's written instructions to protect wall assembly from degradation. Prime substrates, if required, and install flashing to comply with EIFS manufacturer's written instructions and details.

3.4 INSTALLATION OF JOINT SEALANTS

A. Prepare joints and apply sealants, of type and at locations indicated, to comply with applicable requirements in Division 07 Section 07 92 00 -Joint Sealants and in ASTM C 1481.

3.5 CLEANING AND PROTECTION

A. Remove temporary covering and protection of other work. Promptly remove coating materials from window and door frames and other surfaces outside areas indicated to receive EIFS coatings.

END OF SECTION



Section 07 30 00 - Steep Slope Roofing

Scope of Work

This Section includes fiberglass shingles, clay roof tile, slate shingles, standing seam metal roofs, underlayment, wood stringers, flashings, plastic cement and fasteners.

Quality Assurance

The design of all roof cover systems should be designed in accordance with FM global standards utilizing a FM approved assembly that is rated for the associated wind hazards with appropriate reinforcement at the perimeter edges and corners. Written approval must be obtained from Emory's Project Manager to be in non-compliance with FM Global recommendations. The FM Global Contractor's Form X2688 "Checklist for Roofing System" form, available under FM Global's site for FM Approved roofing Assembles and products, under the "Reference Materials" section, must be submitted with each roof submittal. Where not dictated by the assembly description or construction specifications, all materials should be FM approved. When installing a new clay tile roof or replacing an existing clay tile roof, the system must pass the "Clay Tile Roof Testing Protocol" found in the Testing portion of this section.

Execution

When reroofing, attic inspection is required to ensure structural members are in sound condition and the existing deck is adequate for the installation of a shingle roof. When reroofing, replace attic ventilation devices within the field of the roof (e.g., static vents, ridge vents). It is possible to retain intake and exhaust vents not in the field of the roof (e.g., soffit vents, gable vents), provided they remain functional when reroofing is complete. Follow vent product manufacturers' installation instructions. Model building codes require that the product manufacturers' installation instructions be followed. Please note that some building codes require ventilation to be updated to code required levels when reroofing.

The contract document will include the following roof system warranties unless modification to this requirement has been reviewed and approved by Emory University.

Roof System Warranties:

- 1. A 5-year labor and material warranty provided by installer for all systems.
- 2. Clay tiles and slate shingles require a 75-year material warranty.
- 3. Asphalt shingles roofing system require a 30-year material warranty.
- 4. Standing seam metal roofs require a 20-year labor and materials "weathertightness" warranty.

Products

Specifications for products included in this Section and accessories shall meet the ANSI and ASTM criteria for each material.

- 1. Flashings and sheet metal accessory / fabrications shall be copper unless reviewed and approved by Emory University.
- 2. All wood products used for blocking or stringers must be pressure treated.
- 3. Underlayment shall be a 40 mil sheet membrane. Basis of design is W.R. Grace Ice and Water Shield.
- 4. Roof penetrations shall be metal (not PVC), placed away from walls and curbs and spaced 6" apart for watertight detailing.
- 5. Roof material, insulation, felts, flashing, seaming or patching mastics, paints or any roof component system used at Emory shall not contain asbestos. Verification from the manufacturer shall be submitted to Emory in letterform stating such information. Emory Environmental Health and Safety Office retains the right to randomly collect samples prior to their installation and have the material sampled. An accredited laboratory will then analyze these samples. Should said materials contain asbestos it shall be the responsibility of the contractor to replace with materials found not to contain asbestos.



6. Roof flashings, solder, scuppers, downspouts and paints shall not contain lead due to the leaching potential from rainwater and the possibility of lead contamination to the surrounding environment. Verification from the manufacturer of stated items must be received in writing prior to installation and found to be acceptable to Emory.

Tile Roofing

Clay Roof Tile shall be Ludowici or Santa Fe, unless approved by Emory University prior to the start of any construction activity on a project. Low slope roofs shall not have less than a 2% slope or be below the acceptable limit of the roofing manufacturer, whichever is more stringent.

1. Standard Specification for Clay Roof Tiles Grade 1, Class A Per ASTM C1167

Asphalt Shingles

Underlayment shall be a 40-mil sheet membrane. Basis of design is W.R. Grace – Ice and Water Shield. Double layer of underlayment in all valleys.

- 1. Glass-Fiber-Reinforced Asphalt Shingles
 - a. Multitap-Strip Asphalt Shingles: ASTM D 3462, glass-fiber reinforced, mineral-granule surfaced, and self-sealing
 - b. Available Products:
 - i. Atlas Roofing Corporation;
 - ii. CertainTeed Corporation;
 - iii. GAF Materials Corporation;
 - iv. Georgia-Pacific Corporation;
 - v. Owens Corning;
 - vi. TAMKO Roofing Products, Inc.;
- 2. Tab Arrangement: Architectural laminate styling
- 3. Strip Size: Manufacturer's standard.
- 4. Algae Resistance: Granules treated to resist algae discoloration

See Warranty Requirements noted under Execution Section

See ARMA's "Ventilation" Fast Facts and ARMA's Residential Asphalt Roofing Manual for additional information.

Slate Shingles

Underlayment shall be a 40-mil sheet membrane. Basis of design is W.R. Grace – Ice and Water Shield. Double layer of underlayment in all valleys

- 1. Slate Shingles: ASTM C 406, Grade S1; hard, dense, and sound; chamfered edges, with nail holes machine punched or drilled and countersunk. No broken or cracked slates, no broken exposed corners, and no broken corners on covered ends that could sacrifice nailing strength or laying of a watertight roof.
- 2. Refer to <u>https://slateassociation.org/types-slate-roofs/</u> for more information on slate roof types.

See Warranty Requirements noted under Execution Section.

Standing Seam Metal Roof Systems

Underlayment shall be a 40-mil sheet membrane. Basis of design is W.R. Grace – Ice and Water Shield. Double layer of underlayment in all valleys. Standing seam systems are used for a wide range of applications and projects. These systems feature interlocking seams that connect panels.

- 1. Basis of Design: McElroy Metals
- 2. <u>https://www.mcelroymetal.com</u>
- 3. 24-gauge Kynar coated steel or aluminum

See Warranty Requirements noted under Execution Section.



TESTING

For existing, in-place clay tile, slate shingles, metal and asphalt shingle roofs, new construction, or roof replacements:

- Determine the wind load requirements (FMG Loss Prevention Data 1-28)
- Determine the wind-up lift requirements (FMG Loss Prevention Data 1-29)
- Complete pull test to ensure the existing roof assembly is constructed in a manner as to meet FMG requirements.
- Prior to installation of new clay tile roof, complete pull test to ensure the existing roof assembly is constructed in a manner as to meet FMG requirements.

Pull Test Procedures:

- Pull-test will be conducted using ANSI/SPRI FX-1-2006 or most current version
- (Standard Field Test Procedures For Determining The Withdrawal Resistance Of Roofing Fasteners).
- The results of these tests will be compared to the FMG Property Loss Prevention Data Sheet 1-28 and 1-29 requirements to determine if adequate pull-out resistance is achieved. The results of these tests will be either pass or fail.

Additional References:

- 1. ASCE Standard 7-98, Minimum Design Loads for Buildings and Other Structures
- 2. FMG Data Sheet 1-9, Roof Anchorage
- 3. FMG Data Sheet 1-31, Metal Roof Systems
- 4. FMG Data Sheet 1-49, Perimeter Flashing
- 5. FMG Data Sheet 1-52, Field Uplift Testing
- 6. Manufacturer's independent testing results

SUSTAINABILITY

Emory encourages the use of lower heat island effect roof materials and colors. Design team will review options with Emory Project Manager.

ACCESSORIES

Snow Guards

Depending on the type of roof a Pad-style Half Round Pad-Style Snow Guard with Hook by Alpine snow guards is to be considered the basis of design.



Section 07 50 00 - Built-Up Bituminous Roofing

Scope of Work

This Section includes the components of a complete built-up roof system, including vapor retarder, insulation, roof membrane, base flashings, roof asphalt, roof accessories and roof ballast.

Quality Assurance

The design of all roof cover systems should be designed in accordance with FM global standards utilizing an FM approved assembly that is rated for the associated wind hazards with appropriate reinforcement at the perimeter edges and corners. Written approval must be obtained from the Emory Project Manager to be in non-compliance with FM Global recommendations. The FM Global Contractor's Form X2688 "Checklist for Roofing System" form must be submitted with each roof submittal. This form is available under FM Global's site for FM Approved roofing Assembles and products, under the "Reference Materials" section, Where not dictated by the assembly description or construction specifications, all materials should be FM approved

BUILDING CODES

The following link is a general overview of Georgia's Construction Code Program, including enforcement, local amendments, current codes, and whom to call if you have questions regarding construction codes and related issues in Georgia.

https://www.dca.ga.gov/local-government-assistance/construction-codes-industrializedbuildings/construction-codes

Testing

The following shall be completed by the Roofing Contractor and attested by the commissioning body or approved owner agent:

- Low-slope roofing membrane systems which are capable of serving as waterproofing systems shall be flood-tested for water-tightness after installation over low-slope roof decks is complete.
 - The Contractor shall plug all roof drains and/or erect temporary dams in the roof areas being tested and flood the areas with water up to a maximum depth of two (2) inches at the high point. Maintain this water level for a minimum of twenty-four (24) hours or as required by the manufacturer.
 - If structural calculations indicate an unacceptable hazard in flooding roof areas with associated drains plugged, the Contractor shall instead apply continuously flowing water over the waterproofing membranes. If this option is used, the Contractor shall allow water to flow over the membrane for a minimum of twenty-four (24) hours or as required by the manufacturer without closing any drains or erecting dams.
 - Repair or replace any areas that allow water infiltration.
 - Repeat test until there is no water leakage.
- Conventional low-slope roofing membrane systems (i.e., non-green, non- PMR, non-IRMA, etc.,) shall also be tested for water-tightness.
 - The Contractor shall flood areas at the roof drain sumps. After completion of membrane installation, plug roof drains and fill with water to the edge of the drain sump for eight (8) hours.
 - If present, do not plug any secondary overflow drains at the same time as adjacent primary drains.
 - To ensure some drainage from roof, do not test all drains at the same time.
 - The Contractor shall measure water at the beginning and end of the test period. If water level falls, remove water, thoroughly dry the drain area, inspect the installation and the



corresponding underside of the deck penetration, and repair or replace roofing at drain to provide for a properly installed and watertight flashing seal.

- Repeat test until there is no water leakage.
- When precipitation occurs during the test period, the Contractor shall repeat the test.

Products

Specifications for products included in this Section and accessories shall meet the ANSI and ASTM criteria for each material, shall be UL listed and labeled, and shall meet the NRCA Roofing and Waterproofing Manual recommendations. The roofing system design shall meet the criteria to be listed for a UL Class A exposure. The contract documents shall require that Emory University receive a 20-year total system warranty on roofing systems, unless a modification to this requirement has been reviewed and approved by Emory University on a case-by-case basis.

Roof material, insulation, felts, flashing, seaming or patching mastics, paints or any roof component system used at Emory shall not contain asbestos. Verification from the manufacturer shall be submitted to Emory in letter form stating such information. Emory Environmental Health and Safety Office retains the right to randomly collect samples prior to their installation and have the material sampled. An accredited laboratory will then analyze these samples. Should said materials contain asbestos it shall be the responsibility of the contractor to replace with materials found not to contain asbestos.

Roof flashings, solder, scuppers, downspouts and paints shall not contain lead due to the leaching potential from rainwater and the possibility of lead contamination to the surrounding environment. Verification from the manufacturer of stated items must be received in writing prior to installation and found to be acceptable to Emory.

The following products have been reviewed and approved by Emory University:

- Johns Manville
- Soprema
- Tremco
- Firestone

Other manufacturers may only be considered if reviewed and approved by Emory University prior to the start of any construction activity on the project. The system design must be specified and detailed with all components illustrated including substrate preparation, vapor retarder, insulation, roof membrane, base flashings, roof asphalt, roof accessories and roof ballast.

System specifications must be equal to or exceed the following:

Hot Applied Assemblies: Johns Manville 4 Ply built up roof with ASTM 1863 surfacing and/or 3 plies of Type IV fiberglass felts and an ASTM D 6163 Modified Bitumen Cap sheet.

Cold Applied Assemblies: Solvent free, Cold Process, modified bitumen roof systems shall be 100% solvent free including all insulation, membrane, flashing and related adhesives. The roof system shall consists of a one plus one built-up modified bitumen roof system roof system assembly with the following minimum performance criteria for the base ply, cap sheet and flashing assemblies:

- 1. Roofing Membrane/Flashing Cap Sheet: ASTM 6163 Type III Grade G fiberglass reinforced or ASTM D 6164, Grade G, Type I or II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; suitable for application method specified. Granule Color: White.
- Roofing Base Ply/Flashing Base Ply Sheet: ASTM 6163 Type III S fiberglass reinforced or ASTM D 6164, Grade S, Type I or II, polyester-reinforced, SBS-modified asphalt sheet; smooth surfaced; suitable for application method specified.



The roof system installed should be FM Global approved as listed in the most recent edition of the FM Global Approval Guide.

Single-ply roofing systems are typically not acceptable, but may be considered in special circumstances upon prior written approval by the Emory University Project Manager.

Built up bituminous roofing systems shall, at a minimum, meet the following performance standards: multiply SBS assembly, 20 year total system warranty as outlined below, minimum slope of roof deck ¼" per foot and no ponded water after 24 hours.

Warranties from date of Substantial Completion

The contract documents must include requirements for inspection and review of the substrates under the roofing system(s) and complete details showing installation of the roofing system in compliance with all requirements of FM Global, UL, governing authorities and codes and the manufacturer. A representative of the manufacturer shall be available to inspect the roofing installation upon request by Emory University and shall inspect and approve roofing installation before acceptance by Emory University.

Warranty: Manufacturer's "Total System Warranty" without monetary limitation, in which manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks warranty includes roofing membrane, base flashings, roofing membrane accessories, cover boards, all metal used on project, base sheets, base sheet fasteners, wind speeds up to 73 mph, and other components of roofing system.

Warranty Period: 20 years from date of Substantial Completion.

Special Project Warranty: Roofing Installer's warranty, on warranty form, signed by Installer, covering Work of this Section, including all components of roofing system roofing membrane, base flashings, roofing membrane accessories, roof insulation fasteners, cover boards, all metal used on project, base sheets, base sheet fasteners, wind speeds up to 73 mph, and other components of roofing system for the following warranty period:

Installer Warranty Period: 5 years from date of Substantial Completion.

Sustainability

Emory supports the use of lower heat island effect roof materials and colors. The design team is encouraged to meet and exceed the requirements of *Sustainable Sites Credit Heat Island Reduction* under the current LEED rating system and should review options with the Emory Project Manager. Additionally, all Emory projects, including major renovations, shall attempt to meet and exceed the requirements of *Materials and Resources Credit Building Product Disclosure and Optimization – Environmental Product Declarations, Materials and Resources Credit Building Product Disclosure and Optimization – Sourcing of Raw Materials and possibly Materials and Resources Credit Building Product Disclosure for this material.*

Generally, the A/E team should review roofing products which meet the Energy Star® and emissivity requirements of the credit. Even if the roof to be installed cannot meet the 75% threshold, consideration should be given to specifying it anyway in order to decrease the overall heat island effect of the building.

ROOF REHABILITATION

With the high cost of replacing roofs, distribution to the on-going operations of the University, waste generated through replacing roofs, rehabilitation of the existing roofs is a sound sustainable viable



Warranty Period: 5 years from date of completion.

FULLY REINFORCED 20/30 YEAR WARRANTY

Manufacturer will repair roof leaks that has been installed on the Building identified that were caused by defects in workmanship or material at no charge and no dollar limit (NDL) to the Owner.

Warranty Period: 20/30 years from date of completion.

Installers warranty signed by Installer and extended system components indicated, on form acceptable to Roofing Manufacturer and Owner.

Warranty Period: 5 years from date of completion.



Section 07 60 00 - Flashing and Sheet Metal

Scope of Work

This section includes sheet metal flashing and trims, flexible flashings, composite flashings, gutters and downspouts.

Quality Assurance

The design of all flashed assemblies and systems and manufacturer's products must be approved by FM Global, reference data sheet 1-49 which covers guidelines for flashing installation or have the written approval of Emory's Project Manager.

Products

Specifications for products included in this Section and accessories shall meet the ANSI, SMACNA and ASTM criteria for each material. Sheet metal flashing and trim shall be specified to be galvanized steel. Use flashing recommended by manufacturer as part of roofing system where applicable (aluminum for aluminum roofing, etc.).

Flexible flashings shall be Neoprene or EPDM. Composite flashings shall be as required for project. Gutters and downspouts shall be copper, unless otherwise required by the design. Variations from these requirements must be reviewed and approved by Emory University.

Execution

The contract documents shall specify and detail the installation of all flashing and sheet metal assemblies, joints and connections to dissimilar materials, including compliance with requirements of ASTM standards and SMACNA recommendations except where exceeded by other requirements.

Roof Specialties Sections

Gutters and Downspouts

- 1. Gutters: Manufactured in uniform section lengths not exceeding 40 feet, with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
- 2. Gutter Supports: Internal gutter brackets are recommended.

Sustainability

All adhesives and sealants that are utilized inside the building's weather-vapor barrier must comply with VOC content and emissions criteria in the current LEED rating system.



Section 07 84 00 – Firestopping

Scope of Work

This section includes all firestopping applications through rated assemblies including their penetrations, joints, and/or gaps that are to be protected with Underwriters Laboratory (UL) tested firestop system and UL listed firestop material.

Regulatory Requirements

All Firestopping material must be tested in accordance to nationally recognized test standards for firestopping systems set by American Society of Testing and Materials and Underwriters Laboratories, and comply with all code and regulatory requirements. The following test standards and code requirements shall be used for firestopping materials and systems.

- 1. ASTM E 814 for through penetration firestopping.
- 2. ASTM E 1966 for construction joint firestopping.
- 3. ASTM E 2307 for perimeter edge fire stopping.
- 4. UL 1479 for through penetration firestopping, L ratings, aging and environmental exposure.
- 5. UL 2079 for construction joint firestopping.
- 6. IBC Section(s) 712 and 713

The Current Adopted Building Code Edition

Quality Assurance

All firestopping systems must be tested and listed by Underwriters Laboratories, approved by Emory University, and the authority having jurisdiction on the project the materials are used. All systems must be tested in accordance to UL and ASTM E standards to provide F and T ratings. Penetrations through rated floor assemblies must provide firestop systems with F and T ratings equal to the hourly rating of the floor penetrated. All firestop products must be free from harmful chemicals, asbestos, ethylene glycol, PCB's, and lead; materials must not require hazardous waste disposal nor chemicals or solvents for cleanup. Firestop material must be able to be installed per manufacturers written instructions in temperatures ranging from 35 degrees F to 120 degrees F, and have the ability to be frozen, thawed and still be useable.

Products

Specifications for products included in this section must have written documentation from Underwriters Laboratories of passing UL accelerated aging and environmental exposure testing. Firestop material is to be manufactured in the United States and comply with all specified requirements.

- 1. Firestop Caulks, Mastics and Sealants:
 - a. Intumescent Sealant is to be water based and free from ethylene glycol available in systems joints and through penetrations. Basis of design "Metacaulk 1000".
 - b. Elastomeric Sealant is to be water based and be capable of protecting joints and through penetrations. Basis of design "Metacaulk 1200 Caulk Grade"
- 2. Intumescent Wraps and Collars:
 - a. Intumescent material is to have UL verification of passing Accelerated aging and environmental exposure testing. Pipe collars must have permanently affixed attachment tabs from the manufacturing. Basis of design "Metacaulk Wrap Strips and Pipe Collars".
- 3. Firestop Sprays and Mastics:
 - a. All materials are to be elastomeric water based with zero solvent content. Material must not re-emulsify when exposed to water. Basis of Design "Metacaulk 1200 Spray and 1100 Spray".
- 4. Membrane Penetration Protection:
 - a. Intumescent putty pads, intumescent box inserts or intumescent cover guards that are listed in the UL directory for membrane penetration protection "CLIV". Putty pads and box inserts must allow for back to back box installation. Basis of design "Metacaulk Putty Pads, Box Inserts, and Cover Guards".
- 5. Cast in Place Device:



- a. Cast in Place firestop device is to be a standalone firestop unit tested and listed by UL to protect blank openings, metallic, plastic, cable, insulated metallic and mixed multiple penetrations in a single device. Cast in Device must be available in 2.5 inch to 6 inch diameter round as well as oval configurations. Basis of design "Rectorseal Cast in Place Device".
- 6. Cable Pass-Through Device:
 - a. Pass-through device shall be a standalone factory made firestop sleeve allowing all series of cable penetrations through the device including but not limited to data, telephone, low voltage, high voltage, power cables, as well as metallic pipe, EMT, metallic conduit, plastic pipe, ENT, insulated metallic pipe, and mixed multiple penetrations through gypsum and masonry walls and floors. Device must be available in round and square configurations and every device must be applicable to new installation and retro fit designs. Sleeve must have a separate wall bracket assembly available in single, double, triple, and six plex configurations. Device must have L ratings of less than 5 cfm with device only, no putty. Basis of design "Rectorseal "Pass-Thru Cable Sleeve".

Warranty and Contractor Qualifications

Firestop installer must warrant the installed firestopping for the life of the building, lack of manufacturer's warranty does not release installer from specified warranty. Firestop manufacturer shall provide a written warranty for products properly installed in building for the sustainable life of the structure, lack of written warranty does not release manufacturer from liability for faulty firestop products. Installing contractor must have a minimum 3 years' experience installing firestop in projects of similar scope and size, contractor must have certification from the firestop manufacturer in the form of a qualification card to show competence in installing firestop material from that manufacturer.

Sustainability

All Emory projects, including major renovations, shall attempt to meet and exceed the requirements of *Materials and Resources Credit Building Product Disclosure and Optimization – Environmental Product Declarations, Materials and Resources Credit Building Product Disclosure and Optimization – Sourcing of Raw Materials and possibly Materials and Resources Credit Building Product Disclosure and Optimization – Materials Ingredients under the current LEED rating system for this material. Fire sealants and spray fireproofing utilized inside the building's weather-vapor barrier must comply with VOC content and emissions criteria in the current LEED rating system.*

SECTION 22 0010 GENERAL PROVISIONS – PLUMBING

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. These Plumbing General provisions specified herein apply to all Sections of Division 22.

1.2 WORK INCLUDED

A. Provide all materials, labor and services as specified in Division 22 and shown on the accompanying drawings.

1.3 DEFINITIONS

- A. Terms: The following definitions of terms supplement those of the General Conditions, and are applicable to all Plumbing Sections.
 - 1. Provide: Furnish, install and connect completely.
 - 2. Piping: Pipe installed with all required fittings, valves and accessories, and forming a complete system.
 - 3. Wiring: Wire or cable installed in raceway with all required boxes, fittings, connectors, and accessories completely installed.
 - 4. Power Wiring: Wiring that supplies the electrical current that flows through a connected motor or heater.
 - 5. Exposed: Revealed to view or subject to weather.
 - 6. Control, interlock and starting circuit wiring: All wiring required by all Plumbing Sections that is not power wiring.
 - 7. Fittings: All connecting pieces of a system.
- B. Drawings: The Mechanical Drawings are diagrammatic except where otherwise specifically indicated. Refer to Architectural and Structural Drawings for building dimensions.
- C. Materials: Refer to the General Conditions. All material shall be suitable for the service and operating conditions of this Specification.

1.4 ABBREVIATIONS

A. The following abbreviations are used in this Division of the Specifications:

AGA	American Gas Association
AHRI	Air Conditioning, Heating, and Refrigeration Institute
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitation Engineers
ASTM	American Society for Testing and Materials
AWWA	American Water Works Association
CDA	Copper Development Association
CISPI	Cast Iron Soil Pipe Institute
FM	Factory Mutual
MSS	Manufacturers Standardization Society of the Valve and Fittings Industry
NEMA	National Electrical Manufacturers Association

NFPA National Fire Protection Association

- NSF National Sanitation Foundation
- NRCS Natural Resources Conservation Service
- PDI Plumbing and Drainage Institute
- UL Underwriters Laboratories

1.5 APPLICABLE CODES

- A. The following shall apply:
 - 1. International Building Code, 2018 Edition, with Georgia Amendments (2020)
 - 2. International Fire Code, 2018 Edition (Contact State Fire Marshal)
 - 3. International Plumbing Code, 2018 Edition, with Georgia Amendments (2020)
 - 4. International Mechanical Code, 2018 Edition, with Georgia Amendments (2020)
 - 5. International Fuel Gas Code, 2018 Edition, with Georgia Amendments (2020)
 - 6. National Electrical Code, 2020 Edition, with Georgia Amendments (2021)
 - 7. International Energy Conservation Code, 2015 Edition, with Georgia Supplements and Amendments (2020)
 - 8. Chapter 120-3-20: Georgia Accessibility Code for Buildings and Facilities.
 - 9. Chapter 120-3-3: Georgia Rules and Regulations for the State Minimum Fire Safety Standards.
 - 10. Emory University Design and Construction Standards, August 2019.

1.6 QUALITY ASSURANCE

- A. This work requires special construction expertise that must be verified through documented experience. Therefore, any major Sub-Contractor submitting a bid for this scope of work must confirm that he has completed similar work. The following requirements for Work Experience and Contracting Experience and Licensing shall be documented and submitted with other required forms.
 - 1. Demonstrated experience in completing installations of at least three (3) similar projects and a minimum of five (5) years' experience involving renovation, additions and new work of domestic water, sanitary, waste and vent piping systems and natural gas piping systems.
 - 2. Contracting Experience and Licensing:
 - a. The Contractor shall have been in business under the present company name for a minimum of five (5) years, shall have a State of Georgia, Master Plumber Class II license. An officer, partner or principal of the Contractor shall be the holder of the License.
 - b. The Contractor shall not have been declared in default on any construction contract within that time.
- B. Experience outlined in paragraphs above must be demonstrated by projects which are complete prior to the bid date for this work.
- C. Bids will not be accepted from Contractors failing to meet the qualifications established or from Contractors failing to submit the required documentation of qualifications.

1.7 SPACE CONDITIONS

- A. All work shall fit the spaces available. Verify all dimensions of the work before commencing fabrication and/or installation.
- B. Minor deviations from the drawings required to conform to space conditions and to provide the required operation, service, or maintenance accessibility shall be made at no additional cost, and subject to approval.

- C. Piping and equipment shall not be installed in electrical equipment rooms. Outside of electrical equipment rooms, do not run piping or locate equipment, with respect to switchboards, panel boards, power panels, motor control centers or dry type transformers:
 - 1. Within 42" in front (and rear if free standing) of equipment; or
 - 2. Within 36" of sides of equipment
 - 3. Clearances apply vertically from floor to ceiling structures.
- D. Hydronic piping shall not be installed above any electrical or control panels.

1.8 RECORD DRAWINGS

- A. Upon completion of the Project, the Contractor shall submit one set of contract prints with red marks indicating As-built conditions of all piping and equipment, and incorporating changes made during construction. A record of as-built conditions shall be kept throughout the Project and shall be used in the preparation of the final record drawings.
- B. The Contractor shall provide digital images (minimum resolution of 1152 x 864 pixels in JPEG standard image file format) delivered via email, thumb drive, or on CD, of any utilities/piping that are installed underground with a reference drawing indicating which direction each picture is taken. The reference drawing shall dimension the utility/piping from a prominent fixed object.

1.9 WARRANTIES AND GUARANTEES

- A. The materials of the plumbing systems shall have the Manufacturer's and/or supplier's Guarantee or Warranty put into effect by execution and filing of any and all related papers. Minimum warranty shall be for one (1) year from date of substantial completion. Date of substantial completion shall be determined by the Owner. If the manufacturer's standard warranty is for a longer period, it shall apply. Obtain service or repair under the terms of and said Guarantee or Warranty in behalf of the Owner.
- B. The installed plumbing systems shall be delivered to the Owner in proper working order. Contractor shall warranty the plumbing system for a period of one (1) year, replace any work or material, which develops defects, excluding normal wear and tear, from the date of substantial completion.
- C. Warranties and Guarantees shall be furnished in exact conformity with the requirements of the General Conditions.

1.10 CONTINUITY OF SERVICE

- A. All work shall be scheduled with that of other trades. The following conditions shall apply to all affected work.
- B. Before disconnecting any existing systems for changes, the Contractor shall:
 - 1. Have all needed materials stored at the job site.
 - 2. Have assurance that all labor and skilled mechanics needed will be available at the proper time.
 - 3. Estimate the time the system will be out of service and inform the Owner in writing.
 - 4. Secure approval of the shutdown dates from the Owner in writing before disconnecting the system.

- C. Work shall be so conducted that the water and gas supply and drainage of existing services will not be interrupted when such services are required for normal usage of the occupied portions of the existing building.
- D. Work shall be done at such time and in such manner as to cause minimum inconvenience to the Owner and as approved by him or his representative. No allowance will be made for lack of knowledge of existing conditions.

1.11 EXISTING CONDITIONS

- A. Existing systems and equipment shall remain unchanged except where otherwise specified or shown on the drawings.
- B. Where pipes or accessories that are to remain in service are disconnected for removal of equipment or because of building alterations, they shall be reconnected to match the existing installation.
- C. The remodeling work to be done in the existing building shall be coordinated with work of other trades. New piping shall be run to point of connection to existing piping and tie-ins shall be made in such a manner as to afford minimum inconvenience to building occupants and operation.
- D. All pipe, valves, fittings, etc. that are removed from the existing building shall become the property of the Contractor and shall be removed from the premises. Due allowances shall be made for this material in the bid.
- E. Existing work shall be relocated as shown on the drawings.
- F. Existing work shall be removed as shown on the drawings.
- G. Work shall include the removal or extension of and connection to parts of the existing work, and all changes in the existing system to make it conform to changes in the building.

1.12 OPERATING INSTRUCTIONS

- A. Instructions: Instruct the Owner's representative in operation of the installed systems. The basis of these instructions shall be those written for inclusion in the maintenance and operating instruction data specified herein. Obtain certificates, signed by the Owner's representative, that these instructions have been received.
- B. Notification: Notify the Owner at least five days before commencing operating period for domestic heating equipment, as specified herein, in order that the Owner's representative may be present during that period.

1.13 DOCUMENTATION

- A. Documents to be submitted prior to request for final inspection:
 - 1. Maintenance Manuals per Section 22 0100.
 - 2. Three copies of multi-year warranties and guarantees bound in a brochure with index listing equipment.
- B. Data to be Delivered at Final Inspection:
 - 1. Record Drawings.
 - 2. Certificate by Owner's representative confirming that operating instructions have been received.

1.14 SUBMITTALS

- A. Procedure: Refer to the GENERAL CONDITIONS and SUPPLEMENTS thereto for submittal procedure of items called for in the Contract Documents.
- B. Submittal data covering the work of this Division will be reviewed only after such items have been reviewed in detail and approved by the Contractor, such approval being indicated by suitable notations or stamp on the data.
- C. Each submittal shall be clearly marked indicating Specification Section and paragraph for which it is intended. Any deviations, exclusions or substitutions from specified material requirements shall be specifically identified in a summary sheet at the front of the submittal.
- D. Where submittal sheets contain multiple products or selections, the specific item being submitted for review shall be clearly indicated with a red arrow (stamped or handwritten). "Catalog" submittals (multiple items contained in the submittal, specific items not identified) will be rejected and not reviewed.
- E. Submit the requested submittals in sufficient quantity to provide two copies in addition to those required by Contractor.
- F. All pump submittals shall include performance curves indicating flow, pressure, efficiency, and power requirements. For pumps, adjacent impeller selections shall be included.
- G. Motor Tabulation on all motors furnished listing the following nameplate data: Horsepower, voltage, phase and full load amps.
- H. Submittal List: See the individual Plumbing Specification Sections for specific submittal requirements.

END OF SECTION

SECTION 22 0100 OPERATION AND MAINTENANCE OF PLUMBING

PART 1: GENERAL

- 1.1 MAINTENANCE AND OPERATING MANUALS
 - A. Provide manual in number of copies indicated under Section 22 0010 General Provisions Plumbing.
 - B. Material submitted in the manuals shall represent the equipment manufacturer, model, and type installed on the project.

PART 2: PRODUCTS

2.1 MAINTENANCE AND OPERATING MANUALS

- A. Maintenance and Operating Manuals shall consist of the following as a minimum:
 - 1. PDF file with job name and Owner's name on cover.
 - 2. Typed index listing name, address, and phone number of the General Contractor, Plumbing Subcontractor, Insulation Subcontractor, and all major equipment suppliers.
 - 3. Table of contents, listing each section, title, and number.
 - 4. All Sections shall be tabbed listing Section numbers.
 - 5. Each item of equipment requiring maintenance and operation data as noted in each specification section shall be provided with an index listing the types of equipment installed. Submittal data shall be included to the extent necessary to identify equipment, including summary sheet, such as model, size, water flow, pressure developed, speed, and motor size. Instructions shall include type and suggested frequency of maintenance, oiling, cleaning, disassembly, and reassembly directions, and wiring diagrams.
 - 6. One section shall include a complete set of record control drawings, bound in a plastic insert, full size, complete with a written sequence of operation for all control systems.
 - 7. Letters, where factory startup or checking has been required, certifying completion of performance.

PART 3: EXECUTION

- 3.1 MAINTENANCE AND OPERATING MANUALS
 - A. All maintenance and operating manuals shall be complete and ready to turn over to Owner's representative at final inspection.
 - B. Incomplete manuals will be returned to the Contractor for complete resubmission. Loose leaf submittal of material at various stages of completion will not be acceptable.

END OF SECTION

SECTION 22 0500 COMMON WORK RESULTS FOR PLUMBING

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This Section of specifications deals with materials and methods pertaining to all work specified under Division 22.

1.2 RELATED SECTIONS

- A. Section 22 0010 General Provisions Plumbing
- B. Section 22 0523 Plumbing Valves and Strainers

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide submittal data showing starter dimensions, weight, electrical requirements, and service access requirements.
- C. Provide submittal data showing motor horsepower, electrical requirements, and efficiency.
- D. Provide submittal data showing firestop systems, including details for penetrations and instructions for installation
- E. Provide manufacturer's instructions, indicate installation and support requirements.
- 1.4 JOB CONDITIONS
 - A. Install all apparatus so as to maintain maximum headroom and clearances consistent with requirements of the drawings and specifications.
 - B. All equipment requiring service shall be installed to permit access for servicing without damage to building structure or finishes.

PART 2: PRODUCTS

- 2.1 SUPPORTS AND HANGERS
 - A. Individual horizontal piping shall be supported as follows:
 - 1. Steel piping with painted clevis hangers.
 - 2. Hangers in contact with copper piping shall be copper plated swivel ring type.
 - 3. Hangers around insulated copper piping shall be painted clevis or galvanized steel swivel ring type.
 - 4. Copper piping exposed adjacent to structure shall be secured with copper plated pipe clamp.
 - 5. All attachments in contact with copper piping shall be copper, copper plated or plastic coated.
 - 6. Horizontal, parallel and adjacent piping shall be supported by gang hangers utilizing PVC coated channel and PVC coated standard pipe clamps or approved equal.
- B. Exposed Vertical Piping shall be supported by attachment to wall at midpoint with offset pipe clamps. Clamp for uninsulated copper piping shall be copper plated or plastic coated.
- C. Hangers and pipe attachments, except where otherwise specified shall be Elcen, Hilti, Michigan Hanger Company, B-Line, or Grinnell.

2.2 STRUCTURAL ATTACHMENTS

- A. Inserts:
 - 1. Individual inserts shall be malleable iron type selected for the type and thickness of the slab and the load to be carried.
 - 2. Continuous inserts shall be formed galvanized steel type selected for the type and thickness of the slab and the load to be carried. Inserts shall be furnished with end caps, closure strips and shall be anchored at 6" O.C.
 - 3. Inserts shall be used in poured in place concrete slabs.
 - 4. Inserts shall be Elcen, Michigan Hanger, Grinnell, or B-Line.
- B. Concrete Fasteners:
 - 1. Fasteners shall be self-drilling type, Locke Mfg. Co. "Bull Dog", Phillips "Red Head", or Diamond "Blue-Cut".
 - 2. Fasteners shall be used in solid masonry walls and shall be used in solid concrete walls.
- C. Toggle Bolts with not less than 1/4" diameter bolts shall be used in hollow type wall construction.
- D. Clamps of configuration compatible with beams and steel members shall be used in steel construction. Clamps shall be Grinnell, Michigan Hanger Company, Elcen, or B-Line.
- E. Hanger rods shall be selected to safely carry the load to be supported and shall not be less than the diameter listed by the hanger manufacturers for the specific size hanger used.
- 2.3 FOUNDATIONS:
 - A. Provide reinforced concrete foundations for all equipment located on floors, 4" high unless noted otherwise.
 - B. Concrete shall be 1:2:4 mix with neatly beveled edges and all surfaces rubbed smooth prior to mounting equipment. Foundations shall be reinforced with No. 3 bars a maximum of 12" o.c. each way and held in place with dowel rods at each corner anchored in the slab. Dowel rods shall not penetrate the slab waterproofing.
- 2.4 PAINTING
 - A. Primers shall be acrylic, corrosion resistant type, selected for the metal or other surface to be painted, with a maximum VOC emission of 150 grams per liter. Sherwin-Williams Pro-Cryl Universal Primer or equal.
 - B. Topcoats shall be acrylic latex base, selected for the material, surface and operating temperature of the equipment or apparatus to be painted, with a maximum VOC emission of 150 grams per liter for non-flat finishes and 50 grams per liter for flat finishes. Sherwin-Williams ProMar 200 (interior metal, black-out), Sherwin-Williams SuperPaint (exterior metal), or equal.

2.5 FIRESTOP SEALANT

- A. Firestop sealant shall be a synthetic elastomer caulk, strip, or sheet designed for use as a one part fire, smoke, and gas sealant. Material shall be intumescent and capable of being installed with caulk gun, shears, and putty knife. Material shall be UL classified and Factory Mutual approved for sealing in floors, walls, or partitions to 3 hour rating per ASTM E-814.
- B. Fire barrier material shall be 3M Fire Barrier Sheet, Strip, and Caulk.

2.6 ASBESTOS

A. All materials used in this work shall be asbestos free.

PART 3: EXECUTION

3.1 INSTALLATION

- A. All work shall be installed plumb and square unless clearly indicated otherwise. Installation shall be performed by competent persons, trained in their respective skills.
- B. Furnish and install equipment complete, including connections, services, and adjustments for systems to operate safely and in compliance with requirements of the contract.
- C. Install each item in full compliance with current recommendations of the manufacturer. Equipment manufacturer or his authorized representative shall furnish services and/or supervision necessary to ensure compliance with this provision. Conflict between manufacturer's recommendation and other contract requirements shall be resolved before installation.
- D. Requirements of the several acceptable manufacturers for each specified item of equipment may vary as to installation details, location and number of connections, dimensions, and weight. Provide all drawings, services, material, and labor necessary for the installation and proper functioning of the equipment furnished.

3.2 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Take precautions to protect all materials and equipment from damage during the construction process.
- B. Do not store materials and equipment outdoors subject to weather without complete weather protection.
- C. Do not install materials or equipment in a partially constructed structure exposed to weather unless all material and equipment is continuously protected from damage by weather or the construction process.
- D. Material and equipment damaged by improper protection during construction is subject to replacement based on the judgment of the Engineer at no cost to the Owner.

3.3 CUTTING AND REPAIRING

A. Cut and repair all walls, floors, and ceilings necessary for the installation of the mechanical work, but no cutting of work of other trades will be permitted without the consent of the Architect or his representative.

B. All cutting and repairing of walls, floors, and ceilings shall be subject to the supervision and approval of the Contractor.

3.4 CLEANING AND FINAL CLEAN-UP

- A. Keep the premises free of waste, debris, and surplus materials.
- B. After equipment has been installed, remove all extraneous materials, rust and stains; blow, vacuum or flush all foreign matter from all equipment.
- C. Identification plates on equipment shall be free of paint and shall be polished.

3.5 MOTOR VOLTAGES

- A. All motor voltages shall be checked with the electrical drawings prior to preparation of submittals or ordering of equipment.
- 3.6 PIPING SUPPORTS AND ANCHORS
 - A. Waste, drain, and relief valve discharge piping shall be securely anchored to structure, equipment or concrete base. Piping shall be located with two inches clear above the floor.
 - B. Combination riser clamps may be used where more than one pipe passes through floors.
 - C. Riser clamps for support of risers shall span penetration of slot or sleeve in floor. In exposed location, use short span clamps.
 - D. Hang all piping so that equipment flanges and connections bear none of weight of piping. At pump suction and discharges, piping shall be supported free of pump casing.
 - E. Horizontal supports shall be spaced as follows:
 - 1. Steel piping at not more than 10' intervals.
 - 2. Copper piping 1-inch and smaller at 8' intervals; larger than 1-inch at 10' intervals.
 - F. Vertical supports shall be spaced as follows:
 - 1. Steel piping at every other story height.
 - 2. Copper piping larger than 1-inch at every other story height; 1-inch and smaller at every story height.

3.7 HANGER SIZES

- A. Hangers shall be sized to fit the pipe except for the insulated piping, in which case hangers shall be of size for pipe and insulation to pass through.
- B. See Insulation for Pipe Saddles.

3.8 STRUCTURAL ATTACHMENTS

- A. Inserts shall be used for individual loads exceeding 150 lbs. Concrete fasteners may be used where approved in writing by Architect for individual loads of 150 lbs. or less.
- B. Inserts shall be secured to the forms before the pouring of concrete. In all spaces with exposed concrete ceilings, the openings not filled with rods and nut shall be filled with cement grout flush with the ceiling.

- C. Shooting of fasteners into the slab shall be allowed only in approved locations.
- D. Devices for connection to the structure shall not be loaded more than 75% of the manufacturer's rated load.
- 3.9 PAINTING
 - A. Except where otherwise specified, painting shall be done under another Division. Surfaces shall be left clean and free from oil.
 - B. Finishes of factory painted apparatus shall be touched up where finish is marred in installation.
 - C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with cold galvanizing compound.
 - D. Interior ferrous pipe and supports exposed to view without removing ceilings or access panels shall be primed and top-coated with two coats of semi-gloss paint, color shall match existing.
 - E. Exterior ferrous piping and supports shall be primed and top-coated with two coats exterior satin finish paint, color shall match existing.

3.10 FIRESTOP SEALING FLOOR AND WALL PENETRATIONS

- A. Where piping, control tubing, and conduit penetrate fire or smoke rated walls and floors, the penetration shall be sealed with fire barrier herein specified.
- B. Fire barrier shall be installed in strict accordance with manufacturer's printed instructions. Material shall be installed with sufficient depth to maintain a fire endurance rating equivalent to that of the adjacent wall or floor.

3.11 LUBRICATION

A. All equipment installed under this division shall be properly lubricated in accordance with the manufacturer's instructions and recommendations before it is operated during the installation period and shall be checked again before final acceptance.

SECTION 22 0523 PLUMBING VALVES AND STRAINERS

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the valves and strainers common to the plumbing piping systems of Division 22.

1.2 RELATED SECTIONS

- A. Section 22 0500 Common Work Results for Plumbing
- B. Section 22 1000 Pipe, Fittings and Accessories Plumbing
- C. Section 22 1005 Plumbing, Piping and Drainage Accessories

1.3 QUALITY ASSURANCE

- A. All valves of a given type shall be by the same manufacturer.
- B. All valves shall have asbestos-free packing and gaskets.
- C. All valves and fittings shall be of Lead Free construction. Lead Free refers to less than 0.25% weighted average lead content in relation to wetted surface of pipe, fittings and fixtures in systems delivering water for human consumption. Any product designed for dispensing potable water shall meet both the NSF/ANSI 61 and NSF/ANSI 372 test standards via third party testing and certification.
- 1.4 SUBMITTALS
 - A. See General Conditions for submittal procedure.
 - B. Provide Individual data sheets with complete system information including mechanical components.
 - C. Provide manufacturer's instructions, indicate any installation and support requirements.
 - D. Provide operation and maintenance procedures; assembly drawings and parts list.

PART 2: PRODUCTS

- 2.1 BALL VALVES
 - A. Valves 2-1/2" and under shall be full port, lead free bronze ball valve rated for 150 psi saturated steam and 600 psi non shock cold working pressure conforming to MSS SP-110 and NSF/ANSI 61 with bronze body, chrome plated vented ball, reinforced PTFE seat ring, stainless steel stem, and coated steel handle with vinyl handle hand grip, and soldered connections.
 - B. Ball valves shall be Apollo, Hammond, Nibco, Powell or Stockham/Crane.

2.2 BUTTERFLY VALVES

- A. Valves 3" size and larger shall be lead free 150 lb class meeting MSS-SP-67 lugged type butterfly valve with ASTM A-126 class B cast iron or ductile iron body, extended neck, lever type, infinite position memory stop handle, stainless steel shaft, bronze or ductile iron disc, stainless steel or bronze shaft bushings and rigid EPDM (BUNA-N) seat designed for service at 200°F minimum. All valves shall be factory tested and guaranteed bubble tight at 150 psi differential. Valves shall be rated for dead end service with downstream flange removed.
- B. Basis of design is Milwaukee model ML233E. Valves may be manufactured by Bray, Grinnell, Hammond, Keystone, Milwaukee or Watts.

2.3 CHECK VALVES IN HORIZONTAL PIPE

- A. Valves 2" and under shall be class 125 all lead free valve with horizontal swing, ypattern, renewable seat and disc,, solder ends, with full flow area, minimum 200 psi non shock cold working pressure conforming to MSS SP-80 and NSF/ANSI 61 with bronze body.
- B. Valves 2¹/₂" and larger shall be class 125 horizontal swing type check valve with cast iron body, flanged, bolted cap, with bronze trim and renewable seat and disc, 200 psi non shock cold working pressure conforming to MSS SP-71, Type 1.
- C. Seats shall be selected for domestic water service.
- D. Valves shall be Hammond, American, Jenkins, Milwaukee, Nibco, or Stockham/Crane.

2.4 CHECK VALVES IN VERTICAL PIPE

- A. Valves 3" and under shall be lead free bronze construction, silent spring type, solder ends with stainless steel spring and resilient seat. Valves shall be class 125 rated for 200 psi non shock cold working pressure.
- B. Valves 4" and over shall be silent cast iron body wafer type, flat face, bronze trimmed, with stainless steel spring and resilient seat. Valves shall be class 125 rated for 200 psi non shock cold working pressure.
- C. Seats shall be selected for domestic water service as required.
- D. Vertical check valves shall be Mueller, American, Milwaukee, Mission, Nibco or Stockham/Crane.

2.5 WATER TEMPERING VALVES

A. MV1 shall include pre-assembled and tested recirculation station. Station shall include lead free, Hi-Lo thermostatic mixing valve which is ASSE 1017 listed. Valve shall have thermal actuator and expandable restrictor, dirt and lime resistant poppet, seat, heavy duty strainer check stops, self-aligning bronze trim and seats and temper-resistant temperature adjustment control. Mixing valve shall be capable of providing minimum of 0.5 gpm tempered water and valve shall be rated for 125 psig service. Valves shall have a mixed temperature adjustment range of 40°F. to 160°F. and setpoint shall be field adjustable. Recirculation station shall include shut-off valves on inlets and outlets, temperature/pressure gauges on inlets, GFCI outlet, and all components mounted to enamel coated uni-strut. System shall include relocated building hot water circulating pump with balancing valve and check valve.

B. System basis of design shall be Bradley NRS-20 Navigator Recirculation Station with HL200 (S59-3200) valve.

2.6 BACKFLOW PREVENTERS

- A. Back-Siphonage, Backflow Preventer: Provide on each hose bibb a bronze body nonremovable backflow preventer. Preventer shall be Watts No. 8A.
- B. Anti-Siphon Vacuum Breaker: Watts No. 288A breaker with angle bronze body and internal trim and brass external trim.
- C. Backflow preventers shall be manufactured by Ames, Febco, Hersey, Watts or Zurn Wilkins.

2.7 GAS VALVES

- A. Gas valves at interior equipment locations, 1" size and below, shall include brass body, chrome plated brass ball, brass stem, glass reinforced PTFE seat with aluminum handle and threaded connections. Valves shall be CSA certified to ½ PSI for indoor appliance connections per ANSI Z21.15/CSA 9. Valves shall meet CGA CR91-002 and ASME B16.44 for 5 PSI indoor shutoff and rated for 600 PSI CWP. Design basis Nibco GB1A series. Gas valves shall be manufactured by Apollo, Hammond, Milwaukee or Nibco.
- B. Gas valves exterior to the building, and interior valves larger than 1" size, shall be lubricated plug type meeting requirements of ANSI/ASME B16.33 with semi steel body and removable handle rated for 125 PSIG. Valves shall be threaded in size 2" and under and flanged over 2" size. Gas valves shall be manufactured by Crane, Flowserve Corporation, Homestead, or Resun.

2.8 GAS PRESSURE REGULATORS

A. Interior Regulators: Regulators shall be dual cut over pressure device, two stage regulation, spring loaded adjustable regulator with aluminum alloy body and cover, Nitrile rubber diaphragm, O-rings and valve, aluminized steel diaphragm pan, external vent limiter for indoor use, filter. Regulator shall include complete lock up in absence of gas flow and 100% bubble tight shutoff. Regulator shall be ANSI Z21.80 / CSA 6.22 certified. See schedule for capacities. Basis of Design Pietro Fiorentini.

2.9 STRAINERS

- A. Strainers 3" and smaller shall be lead free brass or bronze, wye-pattern strainer with solder ends complete with basket rated for 200 psi water, oil, gas at 150°F non shock cold working pressure. Valves shall be NSF 61 certified.
- B. Strainers 4" and larger shall be iron body, flanged, bronze trimmed, bolted cover, tapped outlet, rated for 250 psi water, oil, gas non shock cold working pressure.
- C. Strainer baskets shall be as follows:

Service	Material	Perforation	Open Area
Domestic Water	Brass	1/10"	35%

D. Strainer shall be Mueller, Keckley, Stockham/Crane, or Hoffman.

2.10 PRESSURE GAUGES

- A. Gauges shall be ANSI Grade A, dial indicating type, with 4" dial and stainless-steel case, Plexiglas cover and ring. Bearings shall be bronze.
- B. Accuracy shall be within 1% of full scale range.
- C. Pressure ranges of gauges shall be as follows:

Domestic water: 0-160 psig

- D. Needle valves shall be made of lead free brass with teflon packing.
- E. Gauge cocks shall be lead free, polished brass 200 psi rated cocks with lever handle.
- F. Gauges shall be manufactured by Ashcroft, Marsh, Moeller, Trerice, or Weksler.

2.11 THERMOMETERS

- A. Thermometers shall be industrial type with 9" aluminum case, every angle adjustment mount, plexiglass cover, 6" stem, and separable brass socket with 2¹/₂" lagging extension.
- B. Temperature range of thermometers shall be as follows:

Domestic Cold Water Piping:	0°-100°F.
Domestic Hot Water Piping:	30°-180°F.
Domestic Hot Water Recirc. Piping	30°-180°F.

- C. Accuracy shall be within 1% of full scale range.
- D. TEST WELLS shall be brass with brass plug and chain. Wells shall have 2¹/₂" lagging extension.
- E. Thermometers shall be by Ashcroft, Marsh, Moeller, Trerice, or Weksler. Test wells shall be by same manufacturer.

2.12 P/T TEST PORTS

- A. Provide 1/4" fitting to receive either a temperature or pressure probe 1/8" OD. Fitting shall be lead free brass with two valve cores of Neoprene (Max 200°F) at 500 PSI, or Nordel (Max 275°F) at 500 PSI, fitted with a color coded cap strap with gasket, and shall be rated at 1000 PSI at 140°F.
- B. Contractor shall supply the owner with two (2) pressure gauge adapters with 1/8" OD probe and two (2) five inch stem pocket testing thermometers; 25-125°F for cold water and two (2) 0-220°F for hot water.
- C. Products by Pete's Plug, Armstrong or Watts are acceptable.

PART 3: EXECUTION

- 3.1 VALVE INSTALLATION
 - A. Install valves in accessible locations with stems located in horizontal or vertical positions.
 - B. All strainers shall include a blow down with ball valve and hose end outlet.

C. Install a gas valve and union at each piece of equipment.

3.2 GAS PRESSURE REGULATORS

- A. Pressure regulators shall be provided with access and protected from physical damage.
- B. Where located indoors, the regulator shall include external vent limiter such that regulator vent to the outdoors in not required.
- C. A tee fitting with one opening capped or plugged shall be installed between the regulator and its upstream shutoff valve. The tee fitting shall be positioned to allow connection of a pressure measuring instrument and to serve as a sediment trap.
- D. A tee fitting with one opening capped or plugged shall be installed not less than 10 pipe diameters downstream of the pressure regulator outlet. The tee fitting shall be positioned to allow connection of a pressure measuring instrument.

3.3 PRESSURE GAUGES

- A. Gauges shall be located and installed so as to be conveniently read from the floor.
- B. Gauges shall be installed upright in a vertical plane when not more than seven feet (7') above the floor.
- C. Provide a gauge cock at each pressure gauge installation.

3.4 THERMOMETERS

- A. Install thermometers in wells where shown on the plans. Thermometers shall be located and installed so as to be conveniently read from the floor.
- B. Wells shall be installed vertical or inclined and filled with light oil.

SECTION 22 0553

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1: GENERAL

- 1.1 DESCRIPTION
 - Α. This section specifies the identification requirements for the plumbing systems.

RELATED SECTIONS 1.2

- A. Section 22 0010 General Provisions Plumbing
- Β. Section 22 0500 Common Work Results for Plumbing
- C. Section 22 1005 Plumbing Piping and Drainage Accessories

1.3 SUBMITTALS

- See General Conditions for submittal procedure. Α.
- Β. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- C. Schedules: Submit valve schedule for each piping system, typewritten and produced on 81/2" x 11" bond paper. Include valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and any variations for identification. If addition to framed copies, furnish extra copies for maintenance manuals as specified in Division 1.

SUMMARY 1.4

- Section includes: Α.
 - 1. Pressure Sensitive Adhesive Pipe Markers.
 - Valve Tags and Schedules. 2.
 - Engraved Equipment Markers. 3.

REFERENCES 1.5

- Α. American National Standards Institute (ANSI): ANSI A13.1, latest edition – Scheme for the Identification of Piping Systems.
- Department of Labor 29 CFR 1910.1200. Β.

QUALITY ASSURANCE 1.6

- Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification Α. products of types and sizes required, whose products have been in satisfactory use for a period of five (5) years.
- Β. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification products.

PART 2: PRODUCTS

- 2.1 MECHANICAL IDENTIFICATION MATERIALS
 - A. Provide manufacturer's standard products for each application as referenced in this section.
- 2.2 PIPE MARKERS
 - A. Pressure-Sensitive Type: Provide manufacturer's standard preprinted, permanent adhesive, color-coded pressure sensitive vinyl labels complying with ANSI A13.1. Color-coded plastic adhesive flow directional arrow tape, full circle at both ends of the pipe marker, tape overlapped 1-1/2". Use 1" tape for piping less than 2-1/2", 2" tape for 2-1/2" thru 8" piping; and 4" tape for larger piping.
 - B. Lettering: Comply with ANSI A 13.1 for piping system nomenclature. Abbreviate only as necessary to accommodate marker length.

2.3 VALVE TAGS

- A. Brass Tags: Provide manufacturer's standard brass engraved tags, $1\frac{1}{2}$ " square, black lettering, with $\frac{1}{4}$ " high service indicator on top line and $\frac{1}{2}$ " numbers below.
- B. Valve Tag Fasteners: Use solid brass "S" hooks for installation of valve tags.
- C. Chart Frames: Provide one (1) aluminum 8 ¹/₂" x 11" valve chart frame with glass lens for each valve schedule provided.

2.4 ENGRAVED PLASTIC EQUIPMENT MARKERS

A. Provide manufacture's standard 1/16" engraved equipment tags matching the terminology on schedules as closely as possible. Use black with white letters, 1" x 3" or $1 \frac{1}{2"} x 4"$ for control devices, and valves and 4" x 6" for equipment. Use green with white letters, 3" long x the ceiling grid width for equipment above lay-in ceilings.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Where identification is to be applied to surfaces requiring painting, insulation, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 MARKER LOCATION

- A. Install pipe markers on each system indicated, include arrows showing normal direction of flow.
- B. Schedule of Piping Identification:

Piping Systems and Contents Legends	Tape Background C	olor Stenciled
<u>Water Supply</u> Domestic Cold Water Domestic Hot Water Recirculating	Green Yellow Yellow	Cold Water Hot Water Hot Water Recirculating

Emory Woodruff Residence Hall Flue Expansi	on 22 0553-3
SG-21290EMOWDR	Identification for Plumbing Piping and Equipment

<u>Gas Systems</u> Gas

Yellow

Natural Gas

- C. Locate pipe markers and/or color bands (if required) wherever piping is exposed to view, and at least one marking per room above suspended ceilings. Per the following:
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units mark each branch where there might be a question of flow direction.
 - 3. Near locations where pipes pass through walls, floors, or ceilings or where they enter non-accessible locations.
 - 4. Behind removable panels and other access points permitting view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. On piping above removable acoustical ceilings.
 - 7. At maximum intervals of 40' along each straight pipe run, except to 25' in congested areas.

3.3 PAINTING OF PIPING

- A. See Section 22 0010 General Provisions Plumbing for painting requirements.
- B. Schedule of Piping Paint Color (Note that painting of copper piping is not required):

Piping Systems and Contents	Paint Color
Water Supply	
Gas	Match Existing

3.4 VALVE IDENTIFICATION

A. Provide a valve tag on every, cock, and control device in each piping system. Exclude check valves, valves within factory fabricated equipment units, plumbing fixture faucets, convenience and lawn watering hose bibs, shut-off valves at plumbing fixtures. List each tagged valve in a valve schedule for each piping system.

3.5 EQUIPMENT IDENTIFICATION

- A. Install engraved plastic signs or equipment markers on or near each major item of mechanical equipment and each operational device, per the equipment schedule. Attached tag to the ceiling grid directly under equipment installed above lay-in ceilings. Provide markers for the following general categories of equipment and operational devices.
 - 1. Main control and operating valves including safety devices and hazardous units.
 - 2. Meters, gauges, thermometers, and similar units.
 - 3. Fuel burning units including boilers and heaters.
 - 4. Pumps and similar motor driven units.
 - 5. Tank and pressure vessels.
 - 6. Strainers, filters, water treatment systems, and similar equipment.
- B. Method of Installation: Use stainless steel screws except where adhesive is necessary because substrate cannot or should not be penetrated. Use rivets for tags attached to the ceiling grid.

SECTION 22 0700 PLUMBING SYSTEMS INSULATION

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. Insulation specified in this Section is for insulation used in Division 22 work.
- 1.2 RELATED SECTIONS
 - A. Section 22 1005 Plumbing Piping and Drainage Accessories.
 - B. Section 22 0010 General Provisions Plumbing

1.3 DEFINITIONS

- A. Exposed piping is work that can be seen when the building is complete without opening or removing access doors or panels.
- B. Other piping is considered to be concealed.

1.4 INSPECTION

- A. Surfaces to be insulated shall be clean, dry, and free of foreign material, such as rust, scale and dirt when insulation is applied. Perform pressure tests required by other Sections before applying insulation.
- B. Where existing insulation is damaged due to the new work, repair damage to match existing work or replace damaged portion with insulation specified for new work.

1.5 QUALITY ASSURANCE

- A. Products of the manufacturers listed will be acceptable for use for the specific functions noted. All materials shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such material in either the wet or dry state.
- B. Materials shall be applied subject to their temperature limits. Any methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
- C. Insulation shall be applied by experienced workers regularly employed for this type work.

1.6 RATING

- A. Insulation and accessories, unless specifically exempted, shall have a composite flame-spread rating of not more than 25 and a smoke developed rating of not more than 50. Materials that are factory applied shall be tested as assembled. Materials that are field applied may be tested individually. No fugitive or corrosive treatments shall be employed to impart flame resistance.
- B. Flame Spread and Smoke Developed Ratings shall be determined by Method of Test of Surface Burning Characteristics of Building Materials, ASTM E-84 1997 or UL 723.
- C. Products or their shipping cartons shall bear a label indicating flame spread and smoke developed ratings.

- D. Treatment of pipe jackets to impart flame and smoke safety shall be permanent.
- 1.7 ASBESTOS
 - A. All materials used in this work shall be asbestos free.

PART 2: PRODUCTS

- 2.1 INSULATION APPLICATIONS
 - A. Pipe Insulation Denoted by Type P:
 - 1. Interior concealed Domestic Cold water:
 - a. Type P3 Glass fiber, 1/2" thick.
 - 2. Interior exposed Domestic Cold water:
 - a. Type P3 Glass fiber, 1" thick.
 - 3. Domestic Hot water and Circulating Hot water, interior installations:
 - a. Type P3 Glass fiber, 1" thick for piping up to 2" diameter and 1-1/2" for piping larger than 2"

2.2 ACCESSORY MATERIALS

- A. Low VOC adhesives, sealants and mastics shall be selected as recommended by the insulation manufacturer. Adhesives shall be water based and must comply with the current VOC content limits of the South Coast Air Quality Management District (SCAQMD) Rule #1168, with a maximum VOC emission of 70 grams per liter. Low VOC water based sealants and mastics shall be manufactured to comply with NFPA 90A, UL listed and complying with ASTM E84 and comply with the current VOC limits of the SCAQMD Rule #1168, with a maximum VOC emission of 250 grams per liter. They shall be manufactured by the insulation manufacturer or by Foster, Flintkote, Hardcast, Insul-Coustic, Lion Oil or 3M.
- B. Adhesives, sealants and mastics which secure a vapor barrier material shall be of the vapor barrier type.
- C. Adhesives, sealants and finishes for surfaces above 70°F shall be of the "breather" type.
- D. Insulation jackets shall have a vapor barrier when applied to surfaces subject to sweating in an ambient environment up to 90°F D.B. and 80°F W.B.; including domestic cold water, rainwater, and waste piping receiving condensate discharge.
- E. Where specified, finish jackets for all insulation in the building shall be not less than 8 oz./sq. yd. white, pre-sized glass cloth kraft paper reinforced by Carolina or Twinsburg-Miller.
- F. All finish mastics and sealants shall be white in color, unless noted otherwise.
- G. Staples shall be "outward clinch" or "flare" type.
- H. Galvanized steel wire shall be 20 gauge.
- I. Stainless steel wire shall be 20 gauge.

2.3 INSULATION PIPE SHIELDS

A. Shields shall be galvanized rolled to form a 180° arc. Length of shields shall conform to the following:

Insulation O.D.	Shield Length	Shield Gauge
0-4 inch	12 inch	14 gauge
5-9 inch	18 inch	14 gauge
10-19 inch	24 inch	12 gauge
Over 20 inch	30 inch	12 gauge

2.4 INSULATION DESIGNATION

- A. Type P3 shall be Glass Fiber Insulation, suitable for interior application.
 - 1. Insulation shall be composed of high-density glass fibers bonded with a thermosetting resin. Operating temperature range shall be 0°F to 850°F. Mean thermal conductivity shall not exceed 0.23 at 75°F. Manufacturers shall be Certainteed, Knauf, Owens Corning, or Johns Manville.
 - 2. Insulation finish shall be factory applied all service jacket with pressure sensitive adhesive closures for the longitudinal and butt joints. Jacket permeance shall not exceed 0.02 perms.
 - 3. All valves, thermometer wells, gauge cocks, hose bibbs, air vent piping, and any other components shall be insulated with molded insulation fittings or same thickness elastomeric insulating tape finished with flexible glass cloth and mastic.

PART 3: EXECUTION

- 3.1 GENERAL APPLICATION
 - A. The following general conditions apply to the insulation installation.
 - 1. Insulation shall be clean and dry during installation and during application of any finish.
 - 2. Provide removable and replaceable covers on all pumps and equipment requiring insulation that must be opened periodically for inspection, cleaning, or repair.
 - Install insulation, jackets, and coatings continuous through wall and floor openings and sleeves. See Section 22 0500 regarding fire barrier sealing over insulated pipes passing through rated floors and walls.
 - 4. Banding wires shall have the twisted terminals turned down into the insulation, except where vapor barrier would be punctured.
 - 5. Finish open ends of pipe insulation as specified for fittings.
 - 6. All piping and equipment that are scheduled to be insulated shall have a finished jacket, either factory or field applied.
 - 7. Staples shall be installed only on insulation that does not contain a vapor barrier.
 - 8. For all cold piping systems (waste piping receiving condensate discharge and domestic cold water), <u>all</u> components of the piping system shall be insulated and provided with a continuous vapor barrier. Vapor barriers shall be continuous for entire piping system and shall not be pierced except as specified otherwise.
 - 9. Factory applied jacket shall be the finish jacket unless otherwise noted.
 - 10. Maintain vapor barrier where dissimilar insulation products abut.

3.2 PIPE SHIELDS

A. For all piping, insulation shall be continuous on pipe at pipe hangers with protection shields bearing on the outside of the insulation.

3.3 INSULATION APPLICATION

- A. Type P3 Glass Fiber Insulation:
 - 1. Cover pipe with insulation with each section tightly abutted one to another. Jacket shall be lapped and secured with self-adhesive strip.
 - 2. Abutting ends of insulation shall be covered with 4" wide butt strips smoothly secured with adhesive.
 - 3. Fittings and valves shall be covered with mitered or molded insulation sections secured with galvanized steel wire and finished with smooth coat of white glass fabric and mastic.
- 3.4 FINISH JACKETS
 - A. Pre-sized glass cloth jackets shall be secured by a continuous coating of adhesive applied to a uniform thickness. Jacket shall be smooth without wrinkles. Jacket shall be applied to straight lengths of covering only.
 - B. Flexible glass cloth shall be applied to equipment, valves, fittings, and curved surfaces. Cloth tape shall be smoothly applied and secured with a continuous coat of adhesive. White fabric and mastic to be used on exposed pipe fittings. Tape shall overlap itself and adjacent jackets not less than two inches (2").

SECTION 22 1000 PIPE, FITTINGS AND ACCESSORIES – PLUMBING

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. Piping specified in this Section is for types of pipe and accessories used in Division 22.
- 1.2 RELATED SECTIONS
 - A. Section 22 0500 Common Work Results for Plumbing
 - B. Section 22 1005 Plumbing Piping and Drainage Accessories

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide product data for pipe and fitting materials, indicating conformance with specified standards.

1.4 QUALITY ASSURANCE

- A. Codes and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes and regulations, the drawings and specifications govern.
- B. Pressure/temperature ratings of all components and accessories shall meet or exceed design conditions for the system in which they are installed.
- C. Welding shall be in accordance with procedures of the National Certified Pipe Welding Bureau and shall comply with the requirements of the ANSI Code for Pressure Piping. Welders shall be qualified under the above procedures and certified by the National Certified Pipe Welding Bureau.

PART 2: PRODUCTS

- 2.1 PIPE AND FITTINGS
 - A. Steel Pipe and Fittings:
 - 1. Pipe (up to 12" diameter):

Material	Specification
Schedule 40 Black steel	ASTM A53, latest edition, Grade B

- 2. Fittings:
 - a. 150 lb. SWP malleable iron screwed fittings conforming to ANSI B16.3.
 - b. 125 lb. SWP cast iron flange fittings conforming to ANSI B16.1.
 - c. Standard weight factory fabricated butt welding fittings conforming to ANSI B16.9 and ASTM A-234.
 - d. 150 lb. forged steel welding neck or flat face slip-on flanges conforming to ASTM A181.
 - e. Socket fittings conforming to ANSI B16.11.
 - f. Cast iron drainage pattern fittings conforming to ANSI B16.12.

- g. Dielectric couplings and/or flange kits shall be provided at connections between ferrous and non-ferrous pipe. Provide with high temperature gaskets rated for 300°F steam service.
- h. Unions:
 - 1) Except where otherwise specified, unions in welded piping shall be flanges.
 - 2) Unions in piping 2-inch and smaller shall be 150 lb. malleable iron, ground joint, bronze to iron, screw type.
 - 3) Unions in screwed piping 2¹/₂" and larger shall be 125 lb. cast iron flanges.
- i. Fittings, flanges, and unions in galvanized steel pipe shall be galvanized.
- 3. Joints, unless specified otherwise:
 - a. Screwed Joints: Joint compound shall be "Tite-seal" or Teflon tape, except where otherwise specified.
 - b. Welded Joints: Welding rods shall be compatible with the material to be welded. Welding shall be by electric arc or oxyacetylene methods.
 - c. Flanged joints shall be made up with 1/16" thick, ring type, compressed composition sheet gasket, except for gas piping which shall be made up with aluminum "O" ring type gaskets. Flange bolts shall be steel hexagon head type, conforming to ASTM Specification A-307. Nuts shall conform to ASTM Specification A-193.
- 4. Pipe and fittings shall be made in America unless otherwise approved.
- B. Copper Pipe and Fittings (Soldered):
 - 1. Pipe:

Material	Specification
Type L tube	ASTM B88, latest edition

- 2. Fittings:
 - a. Wrought copper solder joint type conforming to ANSI B16.22. Cast fittings conforming to ANSI B16.18, except where otherwise specified, may be used only in patterns not available in wrought fittings, and where desired changes in direction and/or reduction in size cannot be accomplished with two wrought fittings.
 - b. Adapter fittings shall be provided at all copper to brass pipe connections. Adapters 2" and smaller shall be cast bronze or wrought copper. Adapters larger than 2" shall be 150 lb. cast bronze flanges. Adapters between the meter and the pressure reducing valve shall be 250 lb cast bronze flanges.
 - c. 150 lb. cast bronze flange fittings conforming to ANSI B16.24 downstream of the pressure reducing valves.
 - d. Dielectric couplings and/or flanged kits shall be provided at all copper to steel pipe connections.
 - e. Cast DWV fittings shall conform to ANSI B16.23; wrought DWV fittings to ANSI B16.29.
 - f. Unions:
 - 1) Except where otherwise specified, unions shall be wrought copper or cast bronze.

- Unions in piping 2¹/₂" and larger shall be 150 lb. cast bronze flanges, downstream of the pressure reducing valve and 250 lb between the meter and the PRV.
- 3) Insulating unions shall be provided at all equipment having ferrous connections.
- 3. Copper pipe shall be manufactured by Mueller Industries, Cerro Flow Industries, or Cambridge-Lee Industries.
- 4. Fittings shall be manufactured by Mueller Industries, Cello Products, Nibco, or Elkhart Products.
- 5. Joints, unless specified otherwise:
 - a. Solder Joints: Solder shall be 95/5 (95% tin, 5% antimony) except where otherwise specified. Where specified or noted on the drawings, solder shall have a silver alloy solder having a melting point of not less than 1100°F. NO LEAD SOLDER SHALL BE PERMITTED.
 - b. Solder flux shall be the type recommended by the manufacturer of the 95/5 solder used, meeting ANSI/NSF Standard 61. Silver brazing flux shall be used for solder of 1100°F. or higher melting point.

2.2 SLEEVES

- A. Provide standard weight steel pipe sleeves at all points where piping passes through walls, floors, and ceilings, except where otherwise specified.
- B. #20 U.S. gauge galvanized steel sleeves may be used through all walls and through floors in concealed pipe chases where concrete thickness is 4" or less.

PART 3: EXECUTION

- 3.1 PIPING GENERAL
 - A. All piping shall be run straight and parallel to building construction. All changes in directions shall be made with fittings as specified herein and shown on the drawings.
 - B. All piping shall be installed with allowance for expansion and contraction.
 - C. Pipe connections to equipment that is supported independent of the pipe, including pumps, shall be aligned with the equipment.
 - D. Install piping so as to preserve access to all valves, air vents, and other equipment and to provide the maximum headroom possible.
 - E. All piping, except cast iron, which runs through concrete slabs or walls shall be insulated or caulked in sleeves as hereinafter specified so that the pipe metal does not come in contact with the concrete masonry.
 - F. Equipment Drains, Drips, Etc.:
 - 1. All devices and equipment having drain, drip or blowdown connection shall be piped to nearest floor drain terminating with an elbow over grate, except where otherwise specified.
 - 2. Piping shall be run parallel and plumb to walls and shall be braced to walls, floor, other piping, or equipment.
 - 3. Piping shall be full size of device or equipment connection. Except for relief valve discharges, horizontal drains may be combined into one pipe that is one pipe larger than largest connecting pipe.

- 4. Condensate drains shall be trapped and provided with unions and cleanouts.
- G. Unions shall be provided at all connections to flow control valves, equipment, and apparatus.
- 3.2 PROCEDURES FOR JOINTS IN STEEL PIPING
 - A. Welded Joints:
 - 1. All welding of pipe shall conform to the ASME and ANSI Standards B31.1 Power Piping and B31.9 Building Services Piping.
 - 2. Mitering or notching pipe to form elbows and tees will not be permitted. Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale, and oxidation prior to welding.
 - 3. Before welding, the component parts to be welded shall be aligned so no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.
 - 4. Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to approximately 100°F for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32°F. All welds shall be full penetration welds.
 - 5. Defective welds shall be removed and replaced at no additional cost to the Owner. Repairing of defective welds by adding new materials over the defects or by peening will not be permitted.
 - 6. Electrodes shall be stored in a dry, heated area and shall be kept free of moisture or dampness during fabrication operations. Electrodes that have lost part of their flux shall be discarded.
 - 7. Fire protection safeguards shall be employed in connection with welding operations.
 - 8. No welding will be permitted where communication equipment has been installed.
 - 9. Before any welder shall perform any pipe welding, submit a copy of the Welding Operator Qualification Test as required by the referenced standards cited hereinbefore.
 - B. Screwed Joints:
 - 1. All threads shall be standard, clean cut and tapered. All burrs shall be reamed from inside of the pipe, and pipe shall be turned on end and all loose dirt and scale knocked out.
 - 2. Pipes with threads stripped, chipped or damaged, or split pipe or defective fittings shall not be used.
 - 3. Joint compound shall be applied to the male threads only.
 - C. Flanged Joints: Gaskets shall extend to inside the bolt holes, and flanges shall be brought up truly and water and airtight on gaskets by tightening bolts on opposite sides of the pipe.
- 3.3 PROCEDURES FOR JOINTS IN COPPER PIPING
 - A. Solder Joints:

- 1. Ends of pipe shall be cut square and cleaned with sand cloth so as to remove all oxides before soldering. Fittings shall be similarly cleaned with sand cloth or wire brush.
- 2. Flux shall be evenly applied to both pipe end and fittings.
- 3. Solder shall completely fill all parts of joint. Clean excess flux from pipe after joint completed.
- 3.4 SLEEVES
 - A. Provide all sleeves in walls, roof, etc., as required for installing work of this Division unless otherwise specified hereinafter.
 - B. Sleeves shall be of sufficient size for pipe and full size insulation to pass through.
 - C. Sleeves shall be spaced sufficient distance from adjacent walls and other sleeves so that insulation and/or finish plates may be installed without cutting insulation or plates.
 - D. Sleeves shall be placed on the piping as it is installed to permit installation of sleeves in walls, partitions, and slabs in one piece.
 - E. Omit sleeves where all pipes pass through gypsum board partitions.
 - F. See Section 22 0500 Common Work Results for Plumbing regarding firestop requirements.
- 3.5 PRESSURE TESTING
 - A. See particular piping section for pressure testing requirements.

Plumbing Piping and Drainage Accessories

SECTION 22 1005 PLUMBING PIPING AND DRAINAGE ACCESSORIES

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the types of piping and accessories for the domestic water service and plumbing system.

1.2 RELATED SECTIONS

- A. Section 22 0010 General Provisions Plumbing
- B. Section 22 0100 Operation and Maintenance of Plumbing
- C. Section 22 0500 Common Work Results for Plumbing
- D. Section 22 0523 Plumbing Valves and Strainers
- E. Section 22 0553 Identification for Plumbing Piping and Equipment
- F. Section 22 0700 Plumbing Systems Insulation
- G. Section 22 1000 Pipe, Fittings and Accessories General

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide product data for all manufactured assemblies; including component dimensions, pipe connection sizes, and pressure drop vs. flow (if applicable).
- C. Provide manufacturer's instructions, indicate installation and support requirements.
- D. Provide operation and maintenance data; include start-up instructions, assembly drawings, and parts list.

1.4 QUALITY ASSURANCE

- A. All drains shall be by the same manufacturer.
- B. All pipe and fittings serving potable water systems shall be lead free and shall be certified by NSF International for drinking water.

PART 2: PRODUCTS

- 2.1 INTERIOR DOMESTIC WATER SYSTEM
 - A. Pipe: Type "L" hard copper above ground.
 - B. Fittings: Wrought copper solder type pressure fittings.
 - C. Joints: Solder joints. (Solder joints shall be 95/5 aboveground and silver alloy for buried piping.)
 - D. Flux: Meeting requirements of ANSI/NSF Standard 61.

- E. See Section 22 1000 Pipe Fitting and Accessories Plumbing for additional information.
- 2.2 GAS PIPING SYSTEM (ABOVE GRADE)
 - A. Gas piping shall be schedule 40 black steel pipe.
 - B. Fittings shall be threaded malleable iron in sizes 2" and under and welding type in sizes $2\frac{1}{2}$ " and over.
 - C. See Section 22 1000 Pipe Fitting and Accessories Plumbing for additional information.

2.3 RELIEF VALVE DISCHARGE PIPING

- A. Pipe: Type "L" hard copper.
- B. Fittings: Wrought copper solder type pressure fittings.
- C. Joints: Solder joints. (Solder joints shall be 95/5 aboveground)
- D. Flux: Meeting requirements of ANSI/NSF Standard 61.
- E. See Section 22 1000 Pipe Fitting and Accessories Plumbing for additional information.
- 2.4 HYDRANTS
 - A. HB: Hose Bibbs shall be furnished with integral vacuum breaker, 3/4" hose thread, removable handle, polished chrome finish; Chicago 952 or equal by Prier, Watts, Woodford, or Zurn.
 - B. WH: Non-Freeze wall hydrant shall be cast bronze non-freeze wall hydrant with nickel bronze box face, integral vacuum breaker, backflow preventer, hinged and latched cover. Smith 5509 Series or equal by Josam, Prier, Watts, Woodford, or Zurn.

PART 3: EXECUTION

- 3.1 PIPING GENERAL
 - A. Temporary Closures: During construction period, all rough-in plumbing shall be sealed off with test plugs and caps until fixtures are ready to be installed.
- 3.2 DOMESTIC WATER
 - A. Drains from backflow preventers, air gap devices, and strainers shall be piped to floor drains.
- 3.3 PRESSURE TESTS
 - A. All piping shall be pressure tested before insulation and concealment.
 - B. The following piping shall be tested to the pressure and for the period of time listed and shall hold the specified pressure at the low point of the system for the specified length of time, without perceptible loss of pressure or leakage.
 - C. At the completion of the tests, the Contractor shall submit a letter on his letterhead certifying that the tests have been performed and listing the date of the tests.

- 1. Domestic Water Piping:
 - a. Water piping downstream of the pressure-reducing valve shall be hydrostatically tested at 125 psi for two (2) hours.
 - b. If piping does not hold pressure, test and repair joints. Re-test piping to specified period until test holds.
 - c. Where a new water piping system is to be connected to an existing system, the new system shall be tested as indicated above before connecting to the existing system.
- 2. Gas piping shall be air tested to 30 psig for two (2) hours without loss of pressure. If piping does not hold pressure, then soap test and repair joints. Re-test piping to specified period until test holds.

3.4 PIPE FLUSHING AND STERILIZING

- A. All new potable water piping installed inside the building shall be flushed and sterilized as follows:
 - 1. After the potable water piping systems have been installed, pressure tested, and all plumbing fixtures have been set, the piping shall be sterilized by the addition of chlorinating material. The chlorinating material shall be either liquid chlorine conforming to Federal Specification BB-C-120 or hypochlorite conforming to Federal Specification O-C-114, or Federal Specification O-S-602, Grade A or B.
 - 2. Chlorinating material shall be added in a metered fashion to provide a dosage of not less than 50 parts per million. The chlorinating solution shall remain in the entire piping system for a period of not less than six hours. At the end of the test, a retention of at least 10 parts per million of chlorine shall exist or the test shall be repeated. During the test, all valves in the system shall be opened and closed several times.
 - 3. After the test is completed and satisfactory results obtained, the system shall be drained and flushed to remove the chlorinated solution. The system shall be satisfactorily flushed when the residual chlorine is reduced to two (2) parts per million.
 - 4. At the completion of the test, the Contractor shall submit a letter on his letterhead certifying that the test has been performed and listing the date of the test and the chlorine levels at the beginning and end of the test, and at each stage identified herein.

SECTION 22 1125 PUMPS - PLUMBING

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the pumps and their motors required for the plumbing systems.
- 1.2 RELATED SECTIONS
 - A. Section 22 0010 General Provisions Plumbing
 - B. Section 22 0100 Operation and Maintenance of Plumbing
 - C. Section 22 0500 Common Work Results for Plumbing
 - D. Section 22 0553 Identification for Plumbing Piping and Equipment
 - E. Section 22 0700 Plumbing Systems Insulation

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide product data showing pump curve with system operating point, motor horsepower, electrical requirements and RPM.
- C. Provide shop drawings showing pump dimensions and pipe connection size and accessories.
- D. Provide manufacturer's instructions, indicate installation and support requirements.
- E. Provide operation and maintenance procedures; include start-up instructions, assembly drawings and parts list.

PART 2: PRODUCTS

- 2.1 HOT WATER CIRCULATING PUMPS
 - A. Heat Exchanger Domestic Water Circulating Pumps (HXDP1 & HXDP2):
 - 1. Circulating pumps shall be of the canned-rotor type such that the pump and motor form an integral unit without shaft seal and with only two gaskets for sealing. The bearings are lubricated by the pumped liquid. The pump shall include the following:
 - a. Controller integrated in the control box
 - b. Control panel on the control box
 - c. Control box prepared for optional CIM modules
 - d. Built-in differential-pressure and temperature sensor
 - e. Stainless-steel pump housing
 - f. Twin-head versions
 - g. No external motor protection required

- 2. Motor and electronic controller shall include a high efficiency 4-pole synchronous, permanent-magnet motor (PM motor). The pump speed is controlled by an integrated frequency converter. A differential-pressure and temperature sensor shall be incorporated in the pump.
- 3. Basis of design Bell & Gossett Ecocirc XL or Grundfos Magna3 series.
- B. Pump capacities shall be as scheduled on the drawings.

PART 3: EXECUTION

- 3.1 GENERAL
 - A. Circulating pumps shall be supported from the structure by threaded rod and pipe hangers or a uni-strut frame.
 - B. Test the pump for proper power wiring relating to rotation prior to installing the pump.
 - C. Ensure pump weight is supported by the hangers or frame, not by the connecting piping.

SECTION 22 3400 DOMESTIC WATER HEATING EQUIPMENT

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the domestic water heating equipment.

1.2 RELATED SECTIONS

- A. Section 22 0010 General Provisions Plumbing
- B. Section 22 0100 Operation and Maintenance of Plumbing
- C. Section 22 0500 Common Work Results for Plumbing
- D. Section 22 0523 Plumbing Valves and Strainers
- E. Section 22 0553 Identification for Plumbing Piping and Equipment
- F. Section 22 0700 Plumbing Systems Insulation
- G. Section 22 1000 Pipe, Fittings and Accessories Plumbing
- H. Section 22 1125 Pumps Plumbing

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide shop drawing showing heat exchanger dimensions, capacities, weight, pressure rating, electrical requirements and pipe connection sizes and locations.
- C. Provide shop drawing showing storage tank dimensions, capacities, weight, pressure rating, and pipe connection sizes and locations.
- D. Provide shop drawing showing thermal expansion tank dimensions, capacities, weight, pressure rating, and pipe connection sizes and locations.
- E. Provide shop drawings for control panel showing the proposed wiring diagram with accompanying complete typewritten sequence of operations (if applicable). A symbols list defining all abbreviated components shall be included. A cut sheet on each component used in the system shall be included. The diagram shall delineate between power and control wiring and shall indicate all contactors, relays, and other components of the system. Normally open positions for the relays shall be indicated.
- F. Provide manufacturer's instructions, indicate installation and support requirements.
- G. Provide operation and maintenance data; include start-up instructions, assembly drawings and parts list.

1.4 QUALITY ASSURANCE:

A. The heat exchanger shall comply with the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard and Addendum.

- B. Warranty: A limited warranty shall cover the heat exchanger for leakage, thermal shock, or other malfunction caused by defects in materials and/or workmanship.
- C. Provide certified equipment start-up and, when noted, an in-the-field certified training session. A copy of the start-up report shall be submitted to the Owner and provided in the O&M manual.

PART 2: PRODUCTS

- 2.1 INDIRECT PLATE AND FRAME HEAT EXCHANGER
 - A. Heat exchanger shall be indirect plate and frame type factory-assembled and tested.
 - B. Construction shall be of 316L stainless steel plates, minimum thickness of 0.5 mm, formed into herringbone patterns mounted between a fixed and movable carbon steel head plate with grille rods and tie bolts. Molded one-piece mechanically rated EPDM gaskets shall be installed between stainless steel plate sections. Piping connections shall be ANSI flanged for 150 psi flange connections.
 - C. Heat exchanger shall be a double-wall design, suitable for use with potable water. Capacities shall be as scheduled on the drawings.
 - D. Frame assembly shall be bolted carbon steel construction with no requirement for field welded reinforcement of stiffeners. Frame assembly shall be provided with epoxy-coated finish or two coats of polyurethane paint finish. Aluminum or stainless steel shroud shall cover entire assembly.
 - E. The temperature control shall provide + or 4 degrees Fahrenheit accuracy with up to a 50% change in load. Setpoint range between 90°F and 180°F. Modbus communication shall be standard equipment. The modulating valve shall have a 1000 to 1 turndown.
 - F. The Indirect Plate and Frame heat exchanger shall have a 150 PSI working pressure and be supplied with an ASME temperature and pressure relief valve. Standard equipment shall include Wye Strainers, Isolation Valves, Automatic Air Vent, Scale Reduction Pump, Adjustable High Limit and drain valve.
 - G. Complete assembly shall be assembled and tested in accordance with ASME Boiler and Pressure Vessel Code, Section VIII, Division I, and stamped for a design pressure of 150 PSI for both hot and cold sides and registered with the National Board of Boiler and Pressure Vessel Inspectors. Test pressure shall be at least 150% of design pressure listed.
 - H. Frame shall be sized for the capacity to accommodate a minimum of 20% future additional plates.
 - I. Heat exchanger shall be Lochinvar IPW series or equivalent by Sondex, Bell and Gossett, Mueller, Graham, or Alfa-Laval.

2.2 STORAGE TANKS

A. Storage Tanks shall be a vertical type, jacketed, having a storage capacity as scheduled on the drawings. The tanks shall be constructed with an inner chamber designed to receive all circulation to and from the heat exchanger to eliminate turbulence in the tank. The baffled tank shall supply 80% of tank capacity without a drop in outlet temperature.

- B. The Storage Tanks shall be constructed in accordance with ASME requirements, stamped and registered with the National Board of Boiler and Pressure Vessel Inspectors. The storage tank shall have a working pressure of 150 psi. The storage tank shall be glass lined and fired to 1600°F to ensure a molecular fusing of glass and steel and carry a five (5) year limited warranty. The Lock-Temp Tank shall be constructed with a heavy gauge galvanized steel jacket assembly, primed and prepainted on both sides. The jacket and tank base shall be a watertight construction with a built-in drain pan, complete with a ³/₄" drain connection to assist in protecting against damage in the event of a tank or component leakage. The Storage Tank shall be completely encased in high density insulation of sufficient thickness to meet the energy efficiency requirements of the latest edition of the ASHRAE 90.1 Standard. The entire assembly shall be mounted on "I" beam skids to facilitate handling and installation.
- C. Cathodic protection shall be installed in each tank.
- D. Basis of design is Lochinvar Lock-Temp® "Energy Saver" tanks.
- 2.3 THERMAL EXPANSION TANKS
 - A. Expansion tanks shall be pre-charged to 25 PSIG (adjustable), NSF approved for use in domestic water systems. Tank shall have working pressure of 150 PSIG and maximum temperature of 240°F.
 - B. Tank shall be steel with an epoxy finish and include a NSF/ANSI 61 approved heavy duty butyl bladder with full acceptance volume.
 - C. The tank shall have a NPT connection of brass or stainless steel and incorporate an air charging valve.
 - D. Expansion tank shall be Amtrol Therm-X-Trol, Flexcon Industries, Bell & Gossett, or Sparco.

PART 3: EXECUTION

3.1 HEAT EXCHANGER INSTALLATION

- A. General: Refer to the product installation and operation manual for the manufacturer's complete written installation instructions. The heat exchanger shall be installed in accordance with product installation manual.
- B. Install the loose accessory items furnished with the heat exchanger including, but not limited to, the pressure relief valve, circulating pump, flow switch, and pipe-mounted temperature sensors.
- C. Pipe relief valve discharge the full size of relief valve discharge opening in Type "L" copper pipe to over nearest floor drain. Terminate discharge over drain with indirect connection.
- D. Set heat exchanger thermostat controls to provide 140°F domestic water. Storage tanks shall maintain 140°F water provided to the mixing valve station.
- E. Unit shall be hydrostatically tested for working pressure in accordance with the ASME Code. Any leaks shall be repaired, and the unit retested with a letter from manufacturer's representative witnessing the test.

3.2 STORAGE TANK INSTALLATION

A. Refer to the product installation and operation manual for the manufacturer's complete written installation instructions. The storage tanks shall be installed in accordance with product installation manual.

3.3 EXPANSION TANK INSTALLATION

- A. Expansion tank pre-charge shall be adjusted in the field to match the line pressure of the system which they are serving.
- B. Expansion tank shall be secured to the housekeeping pad by clips or brackets so as not to weld to the tank itself.

3.4 STARTUP

- A. The initial start-up of all heat exchanger(s) shall be performed by a qualified factory representative of the heat exchanger manufacturer. The factory representative shall supervise the start-up and instruct owner's personnel in the proper operation and maintenance of the heaters.
- B. Start-up report shall be submitted in triplicate indicating all operational controls tested and performance documented.

3.5 HEAT EXCHANGER INSPECTION

- A. Heat exchangers shall be checked and certified by the Georgia Office of Insurance and Safety Fire Commissioner prior to startup. Contact the state office at (404) 656-2064 regarding this inspection and pay all fees associated with this inspection.
- B. Provide a copy of the inspection certificate to the Owner.

3.6 TRAINING:

- A. Provide a total of four (4) man-hours of site-specific instruction time provided in two (2) sessions of two (2) hours each (excluding lunchtimes or break times) during regular working hours and on a date as selected by the Owner; one "man-hour" of instruction time shall be one-hour of time provided by the Instructor. Instruction time/training shall be provided at the project site.
- B. Operation and maintenance manuals shall be provided prior to the training session with the Owner's representatives.

SECTION 23 0010 GENERAL PROVISIONS – HVAC

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. These Mechanical General provisions specified herein apply to all Sections of Division 23.
- 1.2 RELATED SECTIONS
 - A. Section 01 9113 General Commissioning Requirements
 - B. Section 23 3100 Ductwork
- 1.3 WORK INCLUDED
 - A. Provide all materials, labor and services as specified in Division 23 and shown on the accompanying drawings.
- 1.4 DEFINITIONS
 - A. Terms: The following definitions of terms supplement those of the GENERAL PROVISIONS HVAC, and are applicable to all MECHANICAL SECTIONS.
 - 1. Provide: Furnish, install and connect completely.
 - 2. Piping: Pipe installed with all required fittings, valves and accessories, and forming a complete system.
 - 3. Wiring: Wire or cable installed in raceway with all required boxes, fittings, connectors, and accessories completely installed.
 - 4. Power Wiring: Wiring which supplies the electrical current which flows through a connected motor or heater.
 - 5. Exposed: Revealed to view or subject to weather.
 - 6. Control, interlock and starting circuit wiring: All wiring required by all Mechanical Sections that is not power wiring.
 - 7. Fittings: All connecting pieces of a system.
 - B. Drawings: The Mechanical Drawings are diagrammatic except where specifically indicated otherwise. Refer to Architectural and Structural Drawings for building dimensions.
 - C. Materials: Refer to the GENERAL CONDITIONS. All material shall be suitable for the service and operating conditions of this Specification.

1.5 ABBREVIATIONS

A. The following abbreviations are used in this Division of the Specifications:

ASTM	American Society for Testing Materials.
ASME	American Society of Mechanical Engineers.
ARI	Air Conditioning and Refrigeration Institute.
SMACNA	Sheet Metal and Air Conditioning Contractors National Association.
ANSI	American National Standards Institute.
NEMA	National Electrical Manufacturers Association
UL	Underwriters Laboratories, Inc.

AWWA American Water Works Association. SCS Soil Conservation Service.

1.6 APPLICABLE CODES

- A. The latest amended editions of the codes applicable to the work of the municipality having jurisdiction.
- B. In the absence of any municipal adopted codes, the following shall apply:
 - 1. International Building Code, 2018 Edition, with Georgia Amendments (2020).
 - 2. International Mechanical Code, 2018 Edition, with Georgia Amendments (2020).
 - 3. International Energy Conservation Code, 2015 Edition, with Georgia Supplements and Amendments (2020).
 - 4. All City, County, State, Regional, and other ordinances applicable to the work shall apply.
 - 5. Emory University Design and Construction Standards, August 2019 Edition.

1.7 APPLICABLE STANDARDS

- A. ASHRAE 52.2-2017 Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size
- B. ASHRAE 55-2017 Thermal Environmental Conditions for Human Occupancy
- C. ASHRAE 62.1-2016 Ventilation for Acceptable Indoor Air Quality

1.8 SPACE CONDITIONS

- A. All work shall fit the spaces available. Verify all dimensions of the work before commencing fabrication and/or installation.
- B. Minor deviations from the drawings required to conform to space conditions and to provide the required operation, service, or maintenance accessibility shall be made at no additional cost, and subject to approval.
- C. Piping, equipment, or ductwork shall not be installed in electrical equipment rooms. Outside of electrical equipment rooms, do not run piping or ductwork, or locate equipment, with respect to switchboards, panel boards, power panels, motor control centers, or dry type transformers:
 - 1. Within 42" in front (and rear if free standing) of equipment; or
 - 2. Within 36" of sides of equipment
 - 3. Clearances apply vertically from floor to ceiling structures.
- D. Hydronic piping shall not be installed above any electrical or control panels.

1.9 RECORD DRAWINGS

A. Upon completion of the Project, the Contractor shall submit one set of contract prints with red marks indicating As-built conditions of all piping, ductwork, and equipment, and incorporating changes made during construction. A record of as-built conditions shall be kept throughout the Project and shall be used in the preparation of the final record drawings.

B. The Contractor shall provide digital images (minimum resolution of 1152 x 864 pixels in JPEG standard image file format) delivered via email or on USB drive, of any utilities/piping that are installed underground with a reference drawing indicating which direction each picture is taken. The reference drawing shall dimension the utility/piping from a prominent fixed object.

1.10 REFRIGERANT WARRANTY

A. Repair of refrigerant systems shall include prompt correction of all leaks and replacement of lost oil and refrigerant.

1.11 GUARANTEES

- A. Furnish a written guarantee covering each category of work for a period of one year from date of legal acceptance for the project. Guarantee shall include prompt correction of all leaks.
- B. Guarantee shall be furnished in exact conformity with the requirements of the General Conditions.

1.12 EXISTING CONDITIONS

- A. In general, all existing HVAC systems and equipment shall be removed from the building unless otherwise specified or shown on the drawings.
- B. All equipment, pipe, valves, fittings, etc., which are removed from the existing building shall become the property of the Contractor and shall be removed from the premises. Due allowances shall be made for this material in the bid.

1.13 OPERATING INSTRUCTIONS

- A. Instructions: Instruct the Owner's representative in operation of the installed systems. The basis of these instructions shall be those written for inclusion in the maintenance and operating instruction data specified herein. Obtain certificates, signed by the Owner's representative, that these instructions have been received.
- B. Notification: Notify the Owner at least five days before commencing operating period for refrigeration and heating equipment, as specified herein, in order that the Owner's representative may be present during that period.

1.14 DOCUMENTATION

- A. Documents to be submitted prior to request for final inspection:
 - 1. Maintenance Manuals per Section 23 0100.
 - 2. Test and Balance Report.
 - 3. Three copies of multi-year warranties bound in a brochure with index listing equipment.
- B. Data to be Delivered at Final Inspection:
 - 1. Record Drawings.
 - 2. Certificate by Owner's representative confirming that operating instructions have been received.

1.15 SUBMITTALS

- A. Procedure: Refer to the GENERAL CONDITIONS and SUPPLEMENTS thereto for submittal procedure of items called for in the Contract Documents.
- B. Submittal data covering the work of this Division will be reviewed only after such items have been reviewed in detail and approved by the Contractor, such approval being indicated by suitable notations or stamp on the data.
- C. Each submittal shall be clearly marked indicating Section and paragraph for which it is intended. Any deviations, exclusions or substitutions from specified material requirements shall be specifically identified in a summary sheet at the front of the submittal.
- D. Where submittal sheets contain multiple products or selections, the specific item being submitted for review shall be clearly indicated with a red arrow (stamped or hand written). "Catalog" submittals (multiple items contained in the submittal, specific items not identified) will be rejected and not reviewed.
- E. Submit the requested submittals in sufficient quantity to provide two copies in addition to those required by Contractor.
- F. All fan and pump submittals shall include performance curves indicating flow, pressure, efficiency, and power requirements. For pumps, adjacent impeller selections shall be included. For fans, alternate RPM curves shall be included.
- G. Motor Tabulation on all motors furnished listing the following nameplate data: Horsepower, voltage, phase and full load amps.
- H. Submittal List: See the individual Mechanical Specification Sections for specific submittal requirements.

1.16 SHOP DRAWINGS GENERAL

- A. Shop drawings shall be complete and shall accurately show all items of equipment and material called for. The number of drawings, and the view contained therein, shall be as needed to show the actual and final routing, construction, and final assembly of each system.
- B. All drawings shall be mechanically produced. Free-hand drawings are not acceptable.
- C. All lettering shall be legible without use or aid of magnifying device. Legible free-hand lettering will be acceptable. Lettering shall be minimum 1/8" size.
- D. Date all shop drawings and provide a revision column.

E. Drawings shall be printed (or plotted) at either 24" high by 36" wide, or the same size as the contract drawings for the same trade, whichever is greater. Each drawing sheet shall be formatted the same as the Contract Documents (i.e., border width, title block, etc.). With the exception of Isometric drawings, all other drawings shall be drawn in two-dimension or at the same scale as the contract drawing of the same area, or as follows, whichever is the larger scale:

Minimum Scale
1/8" per foot
1/8" per foot
1/4" per foot
3/4" per foot
1/4" per foot
1/4" per foot
No scale
1/4" per foot
1/4" per foot
2" per foot

- F. Three-dimensional views may be produced and used to provide supplemental information to that which is given on two-dimensional drawings. Three-dimensional drawings shall be drawn from a 30^o perspective.
- G. Each individual shop drawing sheet shall contain a single format (two-dimensional or three-dimensional).
- H. In addition to information shown on the Contract Documents provide all additional data and notations needed to show conformance with Contract Documents. (i.e., air flow and volume from /to air devices).
- I. For all drawings drawn two-dimension, all characteristics of the Contractor's equipment, systems and components shall be drawn to scale to designate their size. Use of dimensions alone to designate width, height, length, or depth is not acceptable. Drawings will not require that the reader "scale" them to determine sizes or location.
- J. In the event either the project as a whole, or the specific area covered by particular a shop drawing, does not contain columns, floors and/or walls to which reference can be made in the location of items, alternate points of reference, as approved by the Architect, may be used.
- K. Shop Drawings drawn at the same scale as the Contract Drawings shall incorporate the same areas, be arranged and be "broken" along the same lines as the Contract Drawings.

L. Duct and piping system which have following maximum width on one side shall be drawn in the following manner:

Dra Sty	awing Scale Ie	Object Dimension	Object Appearance
1.	1/8" per ft.	Greater than 8"	Double-line
2.	1/8" per ft.	Less than 8"	Single-line
3.	1/4" per ft.	Greater than 4"	Double-line
4.	1/4" per ft.	Less than 4"	Single-line
5.	1/2" per ft.	Greater than 2-1/2"	Double-line
6.	1/2" per ft.	Less than 2-1/2"	Single-line
7.	3/4" per ft.& larger	Greater than 2-1/2"	Double-line
8.	3/4" per ft.& larger	Less than 2-1/2"	Single-line
9.	Flexible duct to diffusers	Single-line	2

- M. Coordinate with all other trades that might impact installation of other systems, equipment or components.
- N. Each Shop Drawing shall contain a title block, which shall be the same size, layout and location, and have the same lettering size, as the Contract Drawings. Each drawing shall bear its own unique and descriptive designation. Adjacent to the title block shall be a space served for revision dates and identification.
- O. Where adjacent areas of the building are continued on separate drawings, provide a "match-line" at the edge of the drawing area with an identifier directing the reader to the appropriate companion drawing.
- P. Each plan view drawing shall contain a "key plan" of the entire building, or a major portion of the building, to allow for the quick identification of the work area covered by the specific drawing and the orientation of the building (or area) as a whole. The key plan shall be proportionally accurate but not to exceed 4" x 4" in size.
- Q. The following minimum information shall be included on each plan view drawing; ceiling, soffits, ceiling grid, light fixtures, partitions, room name and number, columns and other structural members, doors and/or door swings.
- R. Each drawing shall be revised to keep current with all modifications and revisions. Each modification shall be noted in the margin of each affected drawing. Notes shall consist of a unique modification number, date and brief notation on the reason for being made.

1.17 DUCTWORK SHOP DRAWINGS

- A. Background information shall be redrawn scaled versions of the Architectural Floor or Reflected Ceiling Plans of the Contract Drawings and shall show all partitions, openings, and structural features. Drawings from the Contract Documents shall not be copied for use as backgrounds nor will reproducible drawings be made available from the Architect for this purpose.
- B. Show fitting joints, fittings, equipment, required maintenance, removal and safe working clearances, elevations, location and sizes of access panels, net sizes (size of system less insulation), dimension from finished floor and/or overhead structure, horizontal dimension from centerline of columns, direction of flow, changes in size, changes in external covering, system material, construction classification, system name, internal liner, unique situations, equipment designation.
- C. Show floor plan location of all space control and sensing devices (thermostats, humidistats, etc.) complete with the designation of the piece of equipment or component which device controls. Lines drawn between the sensing device to the controlled equipment or component, to designate their interaction, are not acceptable.
- D. Sheet metal work shall be drawn using symbols and designations in accordance with the latest edition of "SMACNA Duct Construction Standards Metal and Flexible".

1.18 HVAC PIPING SHOP DRAWINGS

- A. Background shall be the Ductwork Shop Drawings called for elsewhere in this Section except that notes and details pertinent to only ductwork may be omitted.
- B. Show flanges, fittings, equipment, locations and sizes of access panels, required maintenance, removal and safe working clearances, elevations, net size (size of system less thermal or acoustical coverings), dimension from finished floor and/or overhead structure, horizontal dimension from centerline of columns, grade, percent of slope and/or rate of change, direction of flow, changes in size, changes in external covering, system material, construction classification, system name or symbol, unique situations, equipment designation.
- C. Show floor plan location of all space control and sensing devices (thermostats, humidistats) complete with the designation of the piece of equipment or component which device controls. Lines drawn between the sensing device to the controlled equipment or component, to designate their interaction are not acceptable.
- D. Piping shall be drawn utilizing the symbols and designations as shown on the Contract Documents.
- E. Each piece of equipment or manufactured product shall bear the same designation as indicated on the Contract Documents.

1.19 EQUIPMENT ROOM SHOP DRAWINGS

- A. Background shall be redrawn scaled versions of the Architectural Floor Plan showing all partitions, openings, and structural features.
- B. Show actual size and location of equipment in both plan and vertical section.
- C. Equipment and equipment pads shall be drawn to scale and dimensioned. Dimensions shall conform to actual manufacturer's dimensions for product used.
- D. Show dimensions of equipment placing relative to partitions, columns, beams, and underside of structural deck.
- E. Show and dimension all service clearances, access door swings, vertical clearances.
- F. Show all piping, breaching, pumps, and equipment to provide full information for coordination.
- G. Show electrical panels to scale, including control panels and disconnect switches.
- 1.20 COMMISSIONING REQUIREMENTS
 - A. The contractor shall coordinate all demonstration, training, and system start up of the applicable HVAC equipment with the commissioning agent per specification Section 01 9113.

- B. Refer to specification Sections 01 9113 for additional contractor responsibilities for coordination with the commissioning process and commissioning agent.
- C. Contractor shall be on site during the commissioning Acceptance Testing Phase prior to building occupation, during the Warranty Phase's two (2) HVAC system commissioning off-season tests (August afternoon and January), and during the commissioning 10 month warranty site visit for re-commissioning.

SECTION 23 0100 OPERATION AND MAINTENANCE OF HVAC SYSTEMS

PART 1: GENERAL

- 1.1 MAINTENANCE AND OPERATING MANUALS
 - A. Provide manual in number of copies indicated under Section 23 0010 General Provisions HVAC.
 - B. Material submitted in the manuals shall represent the equipment manufacturer, model, and type installed on the project.
- 1.2 RELATED SECTION
 - A. Section 01 9113 General Commissioning Requirements

PART 2: PRODUCTS

- 2.1 MAINTENANCE AND OPERATING MANUALS
 - A. Maintenance and Operating Manuals shall consist of the following as a minimum:
 - 1. Hardback three ring binders with job name and Owner's name on cover.
 - 2. Typed index listing name, address, and phone number of the General Contractor, HVAC Subcontractor, Insulation Subcontractor, Sheetmetal Subcontractor, and Controls Subcontractor, and all major equipment suppliers.
 - 3. Typed table of contents, listing each Section, title, and number.
 - 4. All Sections shall be tabbed with plastic tabs listing Section numbers.
 - 5. Each item of equipment requiring maintenance and operation data as noted in each specification section shall be provided with an index listing the types of equipment installed. Submittal data shall be included to the extent necessary to identify equipment, including summary sheet, such as model, size, air or water flow, pressure developed, speed, and motor size. Instructions shall include type and suggested frequency of maintenance, oiling, cleaning, disassembly, and reassembly directions, and wiring diagrams.
 - 6. Make, model, serial number and purchase order number of every item of equipment shall be identified on all documentation.
 - 7. One section shall include a complete set of record control drawings, bound in a plastic insert, full size, complete with a written sequence of operation for all control systems.
 - 8. Letters, where factory startup or checking has been required, certifying completion of performance.
 - 9. After the O&M manuals have been reviewed and approved by the Engineer and Commissioning Agent, the contractor shall provide the Owner a digitized version of the manuals on a USB drive in addition to the hard copies provided.
 - 10. Contractor's signed warranty letter certifying all work has been completed as required and stating what date warranty shall end.
 - 11. Table showing all major pieces of equipment and when the warranty of the equipment expires.

PART 3: EXECUTION

- 3.1 MAINTENANCE AND OPERATING MANUALS
 - A. All maintenance and operating manuals shall be complete and ready to turn over to Owner's representative at final inspection. Manuals shall be reviewed and approved by the design professional and commissioning agent prior to submitting to Owner.
 - B. Incomplete manuals will be returned to the Contractor for complete resubmission. Loose-leaf submittal of material at various stages of completion will not be acceptable.
 - C. Contractor to submit to Engineer of Record and Commissioning Agent for review 2 weeks prior to completion of project.

SECTION 23 0131 DUCT CLEANING

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the requirements for cleaning the Division 23 duct systems.
- 1.2 STANDARDS
 - A. Refer to SMACNA "HVAC Duct Construction Standards, Metal and Flexible", latest edition.
 - B. ACR, The NADCA Standard Assessment, Cleaning & Restoration of HVAC Systems, latest version.
 - C. ASHRAE Standard 62.1, Ventilation for Acceptable Indoor Air Quality, latest edition.

1.3 QUALIFICATIONS

A. All work shall be performed by work persons skilled and trained in HVAC system cleaning.

1.4 PROCEDURES

- A. Air sampling:
 - 1. Air samples shall be taken before and after cleaning is performed from the same locations for accurate testing.
 - 2. Sampling shall be conducted in those areas where the greatest potential for particulate deposits exist. These areas include but are not limited to :
 - a. Duct terminations.
 - b. Elbows.
 - c. Turning vanes
 - d. Condensate drain pan.
 - e. Discharge side of the coils.
 - f. Control device surfaces.
 - g. Horizontal surfaces as opposed to vertical surfaces.
 - 3. The minimum number of samples to be tested are as follows:
 - a. 0 1,000 total linear feet of duct: One (1) sample per 200 feet with a minimum of two (2) samples and one (1) field blank.
 - b. 1,001 5,000 total linear feet of duct: One (1) sample per 200 feet for the first 1000 linear feet, one (1) sample per 300 feet after the first 1000 feet, and one (1) field blank for every ten (10) samples.
 - c. 5,001 and over total linear feet of duct: One (1) sample per 300 feet for the first 1,000 linear feet, One (1) sample per 500 feet after the first 1,000 feet, and one (1) field blank for every ten (10) samples.

PART 2: PRODUCTS

- 2.1 VACUUM SYSTEM
 - A. The vacuum system shall pull at least 6000 CFM and shall use a filtration system that incorporates HEPA filtration as a final filter. The compartments shall be dust tight.
 - B. Vacuum calibration shall be as accurate as +/- 5% at 10 liters per minute.

2.2 MATERIALS

A. Provide all instruments, charts, materials, and equipment required to develop a complete report verifying that the duct system has been cleaned.

PART 3: EXECUTION

- 3.1 CLEANING GENERAL
 - A. Clean all duct systems noted on the drawings to be cleaned.
 - B. Schedule shut downs of systems to be cleaned with the Owner. Work shall be confined to un-occupied areas.
 - C. Seal and patch all holes in sheet metal and insulation vapor barriers upon completion of cleaning.

3.2 DUCTWORK CLEANING

- A. Ductwork shall be cleaned by inserting a vacuum hose in one end of the duct or trunk line. With a Reverse Jet Air (RJA) nozzle, brush all interior surface areas of the duct system including reheaters, joints, seams, splitters, turning vanes, scoops, baffles, cracks, and crevices otherwise inaccessible. As the RJA nozzle is operating, the residues shall be drawn into the vacuum unit (minimum 6000 CFM). All foreign materials such as dust, mold, soot, lint, hair, bacteria, and other air movement residues shall be removed from the area.
- B. Special care and attention shall be given to ducts having interior lining materials and light vacuum process shall be used to prevent damage to air side surfaces. All loose fibrous materials shall be removed by a combination of controlled forced air and combined power vacuum method.
- C. Duct Access Openings: Access openings shall be provided at required points of the duct system for physical and mechanical entry. These openings shall be provided as required at points adjacent to turning vanes, dampers, and other obstructions that might tend to trap or entrain dust, dirt, lint, and debris. Duct access openings shall be constructed in accordance with SMACNA HVAC Duct Construction Standards.
- D. Fans shall be cleaned by using 200 psi air pressure and an air nozzle designed for that purpose. Each blade of the fan shall be cleaned individually using care not to disturb any balancing weights.
- E. Containment: Debris removed during cleaning shall be collected and precautions taken to ensure that debris is not otherwise dispersed outside the cleaning area during the cleaning process.

3.3 WORK AREA CLEANING

- A. Area Clean Up: Every precaution shall be taken to prevent the spread of dust and dirt in occupied areas. All desks, computers, and work tables shall be covered with drop cloths while work is performed in that area. A complete area clean up after work cycle is completed shall be performed and no debris shall remain.
- B. Surface Cleaning: After the system has been cleaned and restarted, the entire area served by the clean air distribution system will be dusted. The ceiling shall be lightly brushed to remove any loose dust, walls shall be wiped or brushed, furniture will be dusted, carpet and upholstered furniture will be vacuumed to remove any debris that has been circulated by the HVAC system prior to cleaning.
- C. Grilles and Registers: All grilles, registers, and diffusers which are to remain shall be cleaned with non-toxic, disinfecting solution. Areas around registers shall be lightly cleaned by blowing with air. Cleaning of diffusers shall be completed before test and balance of air flow begins. Leave all areas free of any debris or dust.

3.4 TESTING

- A. Air samples from before and after duct cleaning shall be tested for amount of particles that exist in the air stream. Laboratory results shall be reported in milligrams per 100 centimeters.
- B. Submit complete testing reports, bound in triplicate showing test results before and after work was completed. Identify locations of tests keyed to small duct plan included in report.

SECTION 23 0500 COMMON WORK RESULTS FOR HVAC

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section of specifications deals with materials and methods pertaining to all work specified under Division 23.
- 1.2 RELATED SECTIONS
 - A. Section 01 9113 General Commissioning Requirements
 - B. Section 23 0010 General Provisions Mechanical
 - C. Section 23 0523 HVAC Valves and Strainers
 - D. Section 23 3100 Ductwork

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide submittal data showing starter dimensions, weight, electrical requirements, and service access requirements.
- C. Provide submittal data showing motor horsepower, electrical requirements, and efficiency.
- D. Provide submittal data showing firestop systems, including details for penetrations and instructions for installation
- E. Provide manufacturer's instructions, indicate installation and support requirements.
- 1.4 JOB CONDITIONS
 - A. Install all apparatus so as to maintain maximum headroom and clearances consistent with requirements of the drawings and specifications.
 - B. All equipment requiring service shall be installed to permit access for servicing without damage to building structure or finishes.

PART 2: PRODUCTS

- 2.1 DRIVES
 - A. Belt drives shall be sized for 150% of motor horsepower. Motor pulleys shall be cast iron, adjustable pitch for 15 hp and below, fixed pitch above 15 hp.
 - B. Drive speeds scheduled are estimated; provide fixed or adjustable pitch sheaves necessary to deliver scheduled air quantities based on actual static pressure in the system.
 - C. Multiple belt drives shall be used on motors 5 horsepower and larger.

2.2 DRIVE GUARDS

- A. Drive guards shall be provided for all driven equipment. Drive guards shall be designed to meet OSHA requirements. Belt guards shall be constructed to meet SMACNA Low Pressure Duct Construction Standard, 1985, Appendix Figure 31.
- B. Belt drive guards shall be constructed of galvanized expanded metal reinforced with galvanized angle steel frame. Guard shall be welded or formed of one piece of material.
- C. Provide minimum 3" diameter access plate at motor shaft and driven apparatus shaft for belt guards. Access plates shall be attached with aircraft type locking wing nuts.
- D. Drive guards shall be rigidly bolted to the frame of the equipment. All drive guards shall be removable.

2.3 MOTORS

- A. Provide motors for all equipment required by the Mechanical Sections unless otherwise specified. Motors shall operate using Electrical characteristics shown on the Drawings and as specified. Multiple units of the same manufacturers equipment shall be furnished with motors by one manufacturer. Motors shall be Century, Gold, Louis-Allies, Reliance, General Electric, Balder, Westinghouse, Marathon, or US Motors, except where furnished as part of packaged equipment.
- B. Standards: Except where otherwise specified, motors shall be manufactured according to NEMA Standards. They shall be NEMA Design B, Continuous Duty, 1.15 service factor, Insulation Class B or F, 40°C. ambient and 40°C. rise. Hermetic motors shall be manufactured according to ARI Standards.
- C. Efficiency: All design A & B squirrel-cage, foot mounted, single speed T-frame induction motors 1 hp and larger having synchronous speeds of 3600, 1800, and 1200, rpm shall have a nominal full-load motor efficiency no less than that shown below or shall be classified under NEMA standard as "ENERGY EFFICIENT".
- D. Sizes:
 - 1. Motors with standard NEMA Electrical characteristics shall be selected for the design brake horsepower without overload current at rated voltage. Motor horsepower rating shall not exceed 125% of the calculated maximum load being served. If a standard rated motor is not available within the range, the next larger standard motor size shall be used.
 - 2. Motors with special electrical characteristics, such as hermetic refrigeration motors, shall be selected to product the brake horsepower required for the specified load without overload current at rated voltage.
 - 3. Motors used with variable speed adjustable frequency controllers shall be suitable for inverter duty use, constructed in compliance with NEMA Standard MG 1-1998 Part 31 and selected to operate with the control characteristics and amperage limitations of the specific inverter selected. All motors associated with variable frequency drives shall be furnished with a factory-installed shaft grounding ring (SGR) of conductive micro-fibers to redirect shaft currents from shaft to frame. SGR shall be maintenance-free, brushless, split-ring or complete-ring configuration directly attached with mechanical fasteners. Attachment with adhesives in lieu of mechanical fasteners shall not be an acceptable substitution. SGR shall be by Aegis or equivalent.

- E. Enclosures: Motor enclosures shall be open drip-proof, except where otherwise specified. Motors for equipment installed where subject to weather shall be fan cooled, totally enclosed weatherproof type, unless fully protected by a waterproof housing.
- F. Nameplates: All motors shall have a nameplate showing the specified nominal system voltage as nameplate rated voltage. Each motor shall be guaranteed to operate satisfactorily at the specified nominal system voltage, plus or minus 10%.

2.4 CONTACTORS

- A. Contactors shall be magnetic designed for resistance heating and tested for 100,000 cycles. Contacts shall be silver alloy. Enclosure shall meet the requirements of U.L. 508 with NEMA Type 1 indoors, and Type 3R outdoors. Provide one set of auxiliary contacts and control transformer with fused, grounded secondary. Holding coil voltage shall not exceed 120 volts.
- B. Manufacturers: Clark Controller, Arrow-Hart, Cutler-Hammer, Allen-Bradley, Square D, Joslyn Clark, or Furnas.

2.5 STARTERS

- A. Manufacturers: Cutler-Hammer, Square D, Furnas, Joslyn Clark, Cerus, or Allen-Bradley.
- B. Except as otherwise specified, furnish starter, providing NEMA size, magnetic, full-voltage, non-reversing, single speed (FVNR) with electronic solid-state type overloads sized on the basis of the actual full load running current of the motors furnished; overloads in all three phases. Provide (2) SPDT additional contacts on switch for use by DDC Controls Vendor to monitor position of switch, NEMA A600 rated, for wiring specified under "Controls". Contacts shall be Form C type, open on alarm. Provide (2) additional spare single-pole double-throw (SPDT) contacts. Starters shall be constructed and rated for 42,000 amps withstand rating.
- C. Unless noted otherwise, all automatically controlled motor starters shall be furnished with "hand-off-auto" selector switch, reset button, and red and green LED type pilot lights to indicate "RUN" and "OFF" in cover. Starter doors shall be interlocked to prevent opening of the door with disconnect in the "ON" position, with approved voidable feature.
- D. Combination starters, except those specifically noted to have a fusible disconnect switch, shall also contain a circuit breaker type motor circuit protector with adjustable instantaneous magnetic trip and without thermal trip unit, U.L. listed for motor branch circuit protection. Current limiters shall be provided where required by the available fault current. The frame size, trip rating and setting shall be selected on the basis of the horsepower of the motor as indicated on the Drawings. Disconnect or breaker handle shall have padlocking provisions.
- E. All three phase starters serving motors over 208 volts shall have 120 volt control power transformer, with fused primary and grounded fused secondary. Holding coils shall be 120 volt. Enclosures shall be NEMA Type 1 for indoor locations and NEMA Type 3R for outdoor locations, unless otherwise noted.
- F. All manual single phase starters shall be furnished with red and green LED type pilot lights to indicate "RUN" and "OFF", NEMA Type 1 enclosure indoors, and NEMA Type 3R outdoors. Starters located in finished spaces shall be furnished with flush mounting enclosures.

- G. Provide engraved plastic nameplate for each starter with description of equipment served. Nameplate shall state source of circuit, load served, circuit number if used, voltage and phase.
- H. Provide combination undervoltage/anti-single-phase protection relay, Time Mark Model 265, installed inside starter enclosure.
- I. Provide oversized starter enclosures where required to enable installation of Time Mark device, specified above.

2.6 SUPPORTS AND HANGERS

- A. Individual horizontal piping shall be supported as follows:
 - 1. Steel piping with painted clevis hangers. All pipe insulation shall be continuous through hanger to maintain a vapor barrier
 - 2. Hangers in contact with heating hot water copper piping shall be copper plated loop type. Pipe insulation may be installed over the hanger.
 - 3. Hangers around insulated HVAC condensate copper piping shall be painted clevis or galvanized steel swivel ring type. All pipe insulation shall be continuous through hanger to maintain a vapor barrier
 - 4. Copper piping exposed adjacent to structure shall be secured with copper plated pipe clamp.
 - 5. All attachments in contact with copper piping shall be copper, copper plated or plastic coated.
 - 6. Horizontal, parallel and adjacent piping shall be supported by gang hangers utilizing PVC coated channel and PVC coated standard pipe clamps or approved equal.
- B. Concealed vertical piping shall be supported as follows:
 - 1. Steel piping with painted riser clamps.
 - 2. Copper piping with copper plated riser clamps.
- C. Exposed Vertical Piping shall be supported by attachment to wall at midpoint with offset pipe clamps. Clamp for uninsulated copper piping shall be copper plated or plastic coated.
- D. Pipe in Chases: Piping in pipe chases shall be secured to building structure using attachments hereinbefore specified. Hangers for water piping within plumbing chases shall be supported with rods bolted to pipe clamps which shall be affixed to cast iron pipe. Piping may be supported from the more rigid cast iron pipe with the use of plastic brackets designed for that purpose.
- E. Hangers and pipe attachments, except where otherwise specified shall be Elcen, Hilti, Michigan Hanger Company, B-Line, or Grinnell.

2.7 STRUCTURAL ATTACHMENTS

- A. Inserts:
 - 1. Individual inserts shall be malleable iron type selected for the type and thickness of the slab and the load to be carried.
 - 2. Continuous inserts shall be formed galvanized steel type selected for the type and thickness of the slab and the load to be carried. Inserts shall be furnished with end caps, closure strips and shall be anchored at 6" O.C.
 - 3. Inserts shall be used in poured in place concrete slabs.
 - 4. Inserts shall be Elcen, Michigan Hanger, Grinnell, or B-Line.

- B. Concrete Fasteners:
 - 1. Fasteners shall be self-drilling type, Locke Mfg. Co. "Bull Dog", Phillips "Red Head", or Diamond "Blue-Cut".
 - 2. Fasteners shall be used in solid masonry walls and shall be used in solid concrete walls.
- C. Toggle Bolts with not less than 1/4" diameter bolts shall be used in hollow type wall construction.
- D. Clamps of configuration compatible with beams and steel members shall be used in steel construction. Clamps shall be Grinnell, Hilti, Michigan Hanger Company, Elcen, or B-Line.
- E. Hanger rods shall be selected to safely carry the load to be supported and shall not be less than the diameter listed by the hanger manufacturers for the specific size hanger used.

2.8 FOUNDATIONS

A. Where required, reinforced concrete foundations shall be as specified under the structural scope of work.

2.9 ACCESS PANELS

A. Where required, access panels shall be as specified under the architectural scope of work.

2.10 PAINTING

- A. Primers shall be acrylic, corrosion resistant type, selected for the metal or other surface to be painted, with a maximum VOC emission of 150 grams per liter. Sherwin-Williams Pro-Cryl Universal Primer, or equal.
- B. Topcoats shall be acrylic latex base, selected for the material, surface and operating temperature of the equipment or apparatus to be painted, with a maximum VOC emission of 150 grams per liter for non-flat finishes and 50 grams per liter for flat finishes. Sherwin-Williams Pro-Mar 200 (interior metal, black-out), Sherwin-Williams SuperPaint (exterior metal), or equal.

2.11 FIRESTOP SEALANT

- A. Firestop sealant shall be a synthetic elastomer caulk, strip, or sheet designed for use as a one part fire, smoke, and gas sealant. Material shall be intumescent and capable of being installed with caulk gun, shears, and putty knife. Material shall be UL classified and Factory Mutual approved for sealing in floors, walls, or partitions to 3 hour rating per ASTM E-814.
- B. Fire barrier material shall be 3M Fire Barrier Sheet, Strip, and Caulk.

2.12 ASBESTOS

A. All materials used in this work shall be asbestos free.

PART 3: EXECUTION

- 3.1 INSTALLATION
 - A. All work shall be installed plumb and square unless clearly indicated otherwise. Installation shall be performed by competent persons, trained in their respective skills.
 - B. Furnish and install equipment complete, including connections, services and adjustments for systems to operate safely and in compliance with requirements of the contract.
 - C. Install each item in full compliance with current recommendations of the manufacturer. Equipment manufacturer or his authorized representative shall furnish services and/or supervision necessary to ensure compliance with this provision. Conflict between manufacturer's recommendation and other contract requirements shall be resolved before installation.
 - D. Requirements of the several acceptable manufacturers for each specified item of equipment may vary as to installation details, location and number of connections, dimensions and weight. Provide all drawings, services, material, and labor necessary for the installation and proper functioning of the equipment furnished.
- 3.2 PROTECTION OF MATERIALS AND EQUIPMENT
 - A. Take precautions to protect all materials and equipment from damage during the construction process.
 - B. Do not store materials an equipment outdoors subject to weather without complete weather protection.
 - C. Do not install materials or equipment in a partially constructed structure exposed to weather, unless all material and equipment is continuously protected from damage by weather or the construction process.
 - D. Material and equipment damaged by improper protection during construction is subject to replacement based on the judgment of the Engineer at no cost to the Owner.

3.3 CUTTING AND REPAIRING

- A. Cut and repair all walls, floors, and ceilings necessary for the installation of the mechanical work, but no cutting of work of other trades will be permitted without the consent of the Architect or his representative.
- B. All cutting and repairing of walls, floors, and ceilings shall be subject to the supervision and approval of the Contractor.

3.4 CLEANING AND FINAL CLEAN-UP

- A. Keep the premises free of waste, debris and surplus materials.
- B. The installing contractors must take appropriate precautions during construction to prevent dust and debris from getting into air and water handling systems by covering equipment, controls, and open ended ducts and pipes while installation progresses.
- C. After equipment has been installed, remove all extraneous materials, rust and stains; blow, vacuum or flush all foreign matter from all equipment.

D. Identification plates on equipment shall be free of paint and shall be polished.

3.5 EXCAVATION AND BACKFILL

- A. Do all trenching, excavating, and backfilling required for the Mechanical Sections. Include all necessary repairing, shoring, bracing, pumping and protection for safety of persons and property. Repairing shall be comparable to work cut and shall be approved by the proper authorities.
- B. Slope sides of excavations to comply with OSHA regulations and local ordinances having jurisdiction. Shore and brace where sloping is not possible either because space restrictions or stability of materials excavated. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.
- C. Care shall be taken to avoid existing facilities in excavating. Contractor shall be responsible for all damage to existing facilities in executing this work.
- D. Excavate rock to depth of 6" below bottom of pipe. Space between rock and pipe shall be filled with sand.
- E. Bottom of trenches shall be graded to secure the required fall. Size of bell holes for soil and sewer pipe shall be held to a minimum so that the entire pipe length rests on compacted fill or undisturbed earth.
- F. Backfill shall be placed completely under pipe haunches and in bell holes and uniformly tamped in 6" layers. Backfill over top of pipe with select materials free of clods, stones, boulders, and foreign materials. Back fill shall not be installed until pipe is insulated, tested and field inspected by inspector.
- G. Backfill shall be compacted to 95% of maximum dry density as determined by a Standard Proctor Test, ASTM-D698, except where under areas to be paved, top 12 to 24 inches of fill shall be compacted to 97% dry density by above standard.

3.6 DRIVES AND GUARDS

- A. All belt drive alignments shall be properly checked and set prior to starting machinery.
- B. Adjust drives to deliver air quantities scheduled at actual static pressures. Change sheaves to meet actual conditions, if required.
- C. Provide one set of spare belts to be turned over to the Owner at the completion of the work for each air handling unit drive.
- D. All equipment guards shall be OSHA compliant and installed prior to operation of equipment.

3.7 MOTOR VOLTAGES

A. All motor voltages shall be checked with the electrical drawings prior to preparation of submittals or ordering of equipment.

3.8 MOTOR STARTER OVERLOADS

A. Motor overload heaters shall be sized and installed to protect the actual motor furnished.

3.9 PIPING SUPPORTS AND ANCHORS

- A. Drain and relief valve discharge piping shall be securely anchored to structure, equipment or concrete base. Piping shall be located with two inches clear above the floor.
- B. Combination riser clamps may be used where more than one pipe passes through floors.
- C. Riser clamps for support of risers shall span penetration of slot or sleeve in floor. In exposed location, use short span clamps.
- D. Hang all piping so that equipment flanges and connections bear none of weight of piping. At pump suction and discharges, piping shall be supported free of pump casing through the use of base elbows.
- E. Horizontal supports shall be spaced as follows:
 - 1. Steel piping at not more than 10' intervals.
 - 2. Copper piping 1-inch and smaller at 8' intervals; larger than 1-inch at 10' intervals.
- F. Vertical supports shall be spaced as follows:
 - 1. Steel piping at every other story height.
 - 2. Copper piping larger than 1-inch at every other story height; 1-inch and smaller at every story height.

3.10 HANGER SIZES

- A. Hangers shall be sized to fit the pipe except for the insulated piping, in which case hangers shall be of size for pipe and insulation to pass through.
- B. See Section 23 0700 HVAC Insulation for pipe shields.

3.11 STRUCTURAL ATTACHMENTS

- A. Inserts shall be used for individual loads exceeding 150 lbs. Concrete fasteners may be used where approved in writing by Architect for individual loads of 150 lbs. or less.
- B. Inserts shall be secured to the forms before the pouring of concrete. In all spaces with exposed concrete ceilings, the openings not filled with rods and nut shall be filled with cement grout flush with the ceiling.
- C. Shooting of fasteners into the slab shall be allowed only in approved locations.
- D. Devices for connection to the structure shall not be loaded more than 75% of the manufacturer's rated load.

3.12 ACCESS PANELS

A. Coordinate valve locations with respect to access panels provided under the architectural scope. Valves shall be located so they can be reached by an arm's length through the access panel.

3.13 PAINTING

A. Except where otherwise specified, painting shall be done under another Division. Surfaces shall be left clean and free from oil.

- B. Finishes of factory painted apparatus shall be touched up where finish is marred in installation.
- C. Where galvanizing is broken during fabrication or installation, recoat exposed areas with cold galvanizing compound.
- D. Interior ferrous pipe and supports exposed to view without removing ceilings or access panels shall be primed and topcoated with two coats of semi-gloss paint, color selected by Architect.
- E. Exterior ferrous piping and supports shall be primed and topcoated with two coats exterior satin finish paint, color selected by Architect.
- F. Air handling units and exhaust fans shall be identified as specified in Section 23 0553.
- G. All ductwork, conduits, insulation, pipe and structure visible through grilles and diffusers shall be primed and topcoated with two coats of black egg-shell finish paint.

3.14 FIRESTOP SEALING FLOOR AND WALL PENETRATIONS

- A. Where ductwork, piping, control tubing, and conduit penetrate fire or smoke rated walls and floors, the penetration shall be sealed with fire barrier herein specified.
- B. Fire barrier shall be installed in strict accordance with manufacturer's printed instructions. Material shall be installed with sufficient depth to maintain a fire endurance rating equivalent to that of the adjacent wall or floor.

3.15 REFRIGERATION SYSTEMS

A. Any work required on new or existing refrigeration systems shall involve the use of a refrigeration recovery/recycling unit. All refrigerants shall be stored and reused in the system where the refrigerant condition allows. Intentional release of refrigerant is prohibited and will not be allowed.

3.16 LUBRICATION

A. All equipment installed under this division shall be properly lubricated in accordance with the manufacturer's instructions and recommendations before it is operated during the installation period, and shall be checked again before final acceptance.

SECTION 23 0514 VARIABLE FREQUENCY DRIVES

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the requirements for the adjustable frequency variable torque voltage source drive controller (VFD).
- 1.2 RELATED SECTIONS
 - A. Section 01 9113 General Commissioning Requirements
 - B. Section 23 0010 General Provisions HVAC
 - C. Section 23 0100 Operation and Maintenance of HVAC Systems
 - D. Section 23 0500 Common Work Results for HVAC
 - E. Section 23 0923 Building Automation and Temperature Control System

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide VFD shop drawings, include dimensioned drawings, system wiring diagrams, termination details, data sheets describing all major components and electrical characteristics plainly demonstrating compliance with each specification requirement.
- C. Provide data for each VFD consisting of: Wiring length from VFD to motor, load side accessories, and minimum recommended conductor size.
- D. Provide copy of warranty.
- E. Provide manufacturer's instruction, indicate installation and support requirements.
- F. Provide operation and maintenance procedures; include detailed drawings, parts lists, physical component for layout drawings and control diagrams with wire numbers indicated for controller. Provide manufacturers published recommended procedures for preventative maintenance, repair and normal operation of the controller all components.
- G. Copy of confirmation from manufacturer certifying burn-in of equipment and factory testing.
- H. Copy of manufacturers dated warranty.

1.4 MOTOR PROTECTION

A. Prior to releasing any pricing data on the VFD(s) required for this project, the VFD vendor shall verify the approximate wiring length from the VFD to the associated motor. Based on the specific VFD manufacturer's published recommendations, the VFD vendor shall provide any additional accessorizes (output reactor, output filter, etc.) required to insure reliable, long-term operation of the driven motor. The VFD vendor shall also advise the purchasing party if the VFD manufacturer's published recommendations require larger electrical conductors then are currently shown on the construction documents.

1.5 FACTORY TESTING

- A. The VFD shall be burned in a minimum of 24 hours prior to leaving the factory. During the burn-in period the VFD shall be cycled between no load and full load continuously. The Architect shall be given 72 hours advance notice in writing of factory testing and the Architect and Owner shall be permitted to witness such testing.
- B. During the factory testing, all normal operating modes, indications, controls, failure modes and alarms shall be tested and demonstrated.

1.6 WARRANTY

- A. The VFD shall be warranted by the manufacturer for a period of 36 months from the date of start-up by factory authorized technician. The warranty shall state that all warranty repair will be performed on-site at no cost to the Owner.
- 1.7 FACTORY START-UP SERVICE
 - A. The VFD manufacturer shall provide on-site start-up service performed by a factory trained and authorized technician. The technician shall verify correct installation; start up the drive; check for proper operation; verify wiring to, and driven motor comply with, published recommendations; demonstrate all operational and failure modes to the Owner; assist in interface of the drive with the temperature control system; and provide operational training to the Owner's personnel. The technician shall remain on site at no extra cost to the Owner until the Engineer has acknowledged that all of the obligations listed above have been performed.
- 1.8 DIVISION OF WORK
 - A. The VFD shall receive input from the Automatic Temperature Control System (ATC) specified under another Division. Provide control input interface compatible with input from ATC.
- 1.9 SPARES
 - A. Provide two (2) replacement fuses for each fuse used in the drive.
 - B. Include letter from manufacturer's representative indicating that spare parts are available in 48 hours.

PART 2: PRODUCTS

2.1 GENERAL CHARACTERISTICS

- A. The entire variable speed drive assembly shall be listed by Underwriters Laboratories, Standard UL 508. The variable speed drive shall convert three phase 60hz power to adjustable frequency and voltage, three phase, for stepless motor speed control from 10% to 100% of the motors 60hz speed.
- B. The VFD shall include in one cabinet a converter, an inverter and a manual transfer bypass switch. Input line reactors of 3% impedance or 3% D.C. link reactor shall provided for each variable speed drive. Dimensions shall not exceed those shown on the Drawings.

- C. Full-wave diode bridge rectifiers shall be used on units 25 HP and smaller. Input line noise shall be limited to a voltage distortion factory and line notch depth as defined in IEEE Standard 519-1992, Guide for Harmonic Control and Reactive Compensation of Static Power Converters. The VFD shall comply with the applicable requirements of ANSI, IEEE and NEC. The drive shall be UL/ETL listed and conform to UL 508.
- D. The inverter section of the drive shall invert the variable DC voltage into a waveform.
- E. The continuous output rating shall be 110% of the nameplate full load rating of the induction motor used in fan service as specified under other Divisions.

2.2 REQUIRED FEATURES

- A. NEMA 12 wall mounted enclosure with all operator controls on the front panel. Rear access shall not be required for installation, operation or maintenance. Controller shall be withstand rated for 65,000 amps RMS symmetrical, unless otherwise noted. Enclosure shall be rated for full operating capacity at 104°F.
- B. Hand/Off/Auto Selector.
- C. Manual/Auto selector to select local or remote speed control.
- D. Disconnects for input and bypass power terminals with fuses installed. In lieu of disconnects, equipment may be provided with interlocked input, bypass and output contactors.
- E. Manual speed control locking ten turn potentiometer or Up/Down push-button with infinite speeds.
- F. Indicators for input available, output from drive on, drive fault.
- G. Digital meter indicating percent speed and percent load or RMS amps output.
- H. Two (2) drive running aux contacts for Owner use.
- I. Two (2) Drive fault aux contacts for Owner use.
- J. Auto restart after adjustable time delay (0-300 sec) after loss of input power. No autorestart after fault shutdown. Provide jumper or switch to defeat auto-restart and require manual restart.
- K. Protection against damage from line transients in accordance with IEEE standards.
- L. Protection from damage due to input under or overvoltage and phase loss. Protection from damage due to output current overload or overcurrent. Phase loss monitors shall be provided on both the drive and the bypass.
- M. Protection from damage due to overtemperature within the drive enclosure.
- N. Protection from damage due to DC bus overvoltage.
- O. DC bus discharge circuit for maintenance.
- P. No sensitivity to input phase sequence.
- Q. Input signal isolation circuit to allow use of floating signal with no ground reference.
- R. Compatibility with input signal of type selected by automatic controls vendor. Provide RS 485 communications interface capable of two-way communications.

- S. Three phase motor overcurrent protection.
- T. Analog output signal for remote indication of motor speed, either 0-10v DC grounded or 4-20mA ungrounded.
- U. Permanent machine made wire number on each end of each control conductor. Permanent terminal number for each terminal strip.

2.3 ADJUSTMENTS

- A. Maximum speed: 50 to 100% of base speed.
- B. Minimum speed: 0 to 50% of base speed.
- C. Acceleration time: 3 to 120 seconds.
- D. Deceleration time: 3 to 120 seconds.
- E. Current limit: 0 to 110%.

2.4 SERVICE CONDITIONS

- A. 0 to 40° C ambient.
- B. 0 to 95% relative humidity.
- C. Input line voltage variation +/- 10%.

2.5 ACCEPTABLE

- A. A.B.B.
- B. Danfoss Graham.
- C. No other alternate manufacturer's permitted.

PART 3: EXECUTION

- 3.1 GENERAL
 - A. Contractor shall verify that all motors driven by a VFD shall be inverter duty.
 - B. Install drives as noted on the plans.
 - C. Receive and install the equipment in accordance with the manufacturer's recommendations and instructions. Manufacturer's representative shall start up and place in service, after all adjustments, each variable speed drive. Submit report of final settings for each control point.
 - D. Protect the equipment from moisture and contamination during installation.
 - E. Tighten all bus joints and connections to manufacturers recommended torque settings prior to energization.
 - F. Lace up all wiring using nylon ties.

SECTION 23 0520 PRESSURE GAUGES AND VALVES

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the pressure gauge and gauge valve requirements.
- 1.2 RELATED SECTION
 - A. Section 23 2113 Hydronic Piping

1.3 QUALITY ASSURANCE

A. Gauges shall be manufactured by Ashcroft, Marsh, Moeller, Trerice, or Weksler.

PART 2: PRODUCTS

- 2.1 GENERAL
 - A. Gauges shall be ANSI Grade A, dial indicating type, with 4½" dial and stainless steel case, Plexiglas cover and ring. Bearings shall be bronze.
 - B. Accuracy shall be within 1% of full scale range.

C.	Pressure ranges of gauges shall be as follows:		
	Unless otherwise specified:	0-160 psig	
	Pump suction:	30" vacuum-160 psig	
	Pump discharge:	0 to 160-300 psig	

- D. Needle valves shall be made of brass with teflon packing.
- E. Gauge cocks shall be polished brass 200 psi rated cocks with lever handle.

PART 3: EXECUTION

- 3.1 INSTALLATION
 - A. Gauges shall be located and installed so as to be conveniently read from the floor.
 - B. Gauges shall be installed upright in a vertical plane when not more than seven feet (7') above the floor.
 - C. Provide a gauge cock at each pressure gauge installation.
 - D. Install other gauge cocks and needle valves where shown on the plans.

SECTION 23 0521 TEMPERATURE GAUGES AND TEST WELLS

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the thermometer and thermometer well requirements.
- 1.2 RELATED SECTION
 - A. Section 23 2113 Hydronic Piping
- 1.3 QUALITY ASSURANCE
 - A. Test wells shall be by same manufacturer as thermometer.

PART 2: PRODUCTS

- 2.1 THERMOMETERS FOR GENERAL HYDRONIC SYSTEMS
 - A. Thermometers for general hydronic systems shall be self-powered digital type with hiimpact ABS case, every angle adjustment mount, 3/8" LCD display, -50°F to 300° F temperature range, 3.5" industrial stem, and 1% accuracy of full scale range. Thermometer shall be Weiss Model DVU or Trerice Model SX9.
- 2.2 TEST WELLS
 - A. Test wells shall be brass with brass plug and chain. Wells shall have 2¹/₂" lagging extension.
- 2.3 TEST PLUGS
 - A. Test plugs shall be solid brass temperature and pressure test station, ¹/₄" MPT size, standard length, Nordel valve core, gasketed cap with retaining strap, manufactured by Peterson Equipment Company Inc.
 - B. Furnish a test kit consisting of 0-100 psi pressure gauge, gauge adapter, 25°F-125°F pocket thermometer and protective carrying case.

PART 3: EXECUTION

- 3.1 INSTALLATION
 - A. Install thermometers in wells <u>where shown on the plans</u>. Thermometers shall be located and installed so as to be conveniently read from the floor.
 - B. Wells shall be installed vertical or inclined and filled with light oil.
 - C. Test plugs shall not be covered by insulation.
 - D. Obtain receipt from Owner's representative for test plug kit.

SECTION 23 0523 HVAC VALVES AND STRAINERS

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the valves and strainers common to the heating and air conditioning piping systems of Division 23.

1.2 RELATED SECTIONS

- A. Section 23 0500 Common Work Results for HVAC
- B. Section 23 2000 Pipe, Fittings, and Accessories
- C. Section 23 2113 Hydronic Piping

1.3 QUALITY ASSURANCE

- A. All globe and check valves provided under Mechanical Sections shall be of the same domestic manufacturer, except as otherwise specified.
- B. All other valves of a given type shall be by the same domestic manufacturer.
- C. All valves shall have asbestos-free packing and gaskets.
- D. High zinc alloys, above 15%, are subject to dezincification, since zinc is a very active metal. All brass alloys used in valves shall contain a maximum of 15% zinc.

PART 2: PRODUCTS

2.1 BALL VALVES

A. Ball valves 2" and under shall be two piece cast bronze body, threaded or solder, TFE seat rated for chilled and hot water service, full port, blowout proof stem, separate packnut with adjustable stem packing, solid stainless or chromed ball, 2" extended handles of non-thermal conductive material, handle with memory stop rated for 600 psi non shock WOG, and meeting Federal Specification MSS-SP110. Ball valves shall be Apollo, Hammond, Nibco or Watts.

2.2 BUTTERFLY VALVES

A. Butterfly valves 2½" and larger shall be 150 lb class meeting MSS-SP-67 lugged type with ASTM A-126 class B cast iron or ductile iron body, extended neck, lever type, infinite position memory stop handle, stainless steel shaft, bronze or ductile iron disc, stainless steel or bronze shaft bushings and rigid EPDM (BUNA-N) seat designed for service at 200°F minimum. Valves 6" and larger shall be furnished with weatherproof ASTM A-126 class B iron body worm gear operator and 6" minimum diameter malleable iron rim handwheel. All valves shall be factory tested and guaranteed bubble tight at 150 psi differential. Valves shall be rated for dead end service with downstream flange removed. Butterfly valves shall be Bray, Centerline, Grinnell, Hammond, Keystone, Milwaukee or Watts.

2.3 BALANCING VALVES

- A. Valves 2" and under shall be ball type threaded for steel pipe, solder joint for copper pipe. Valves over 2" shall be flanged. Valves shall be line size, bronze alloy or ductile iron body suitable for shut-off service, memory stop, 200 psig working pressure construction with pressure ports for adjusting flow within ± 3%. Valves shall be Armstrong CBV series, Bell & Gossett Circuit Setter Plus, Flow Set AP series, Victaulic 786/787/788, or Taco Accu-Flo.
- 2.4 TRIPLE DUTY VALVES
 - A. Triple duty valves shall not be permitted.

2.5 STRAINERS

- A. Strainers 2" and smaller shall be 125 lb class iron or bronze body, threaded, 'Y' type complete with screwed cap and basket.
- B. Strainers 2¹/₂" and larger shall be 125 lb class iron body, flanged, bolted cover and tapped outlet.
- C. Strainer baskets shall be as follows: <u>Service</u> <u>Material</u> <u>Perforation</u> <u>Open Area</u> Hot water Brass 1/10" 35%
- D. Strainer shall be Crane, Hoffman, Keckley, Mueller, or Watts.

2.6 GAUGE ISOLATOR

A. Gauge isolators shall be PVC construction with Teflon diaphragm and stainless steel hardware. Isolator shall be filled with glycerine prior to mounted pressure gauge. Plastic gauge isolators shall be Chemline, Nibco or George Fisher, Inc.

PART 3: EXECUTION

- 3.1 BUTTERFLY VALVES
 - A. Butterfly valves shall be used for chilled water and hot water systems sizes 2¹/₂" and larger.

3.2 BALL VALVES

A. Ball valves shall be used for chilled water and hot water systems in pipe sizes 2" and smaller.

3.3 STRAINERS

A. All strainers shall be provided with blow down ball valve with cap and chain.

3.4 INSTALLATION

- A. Ball valves installed in horizontal piping shall have valve stems upright where possible. Butterfly valves shall be installed with the stem in the horizontal position where possible.
- 3.5 GENERAL
 - A. Valves shall be line size unless otherwise noted.

- B. All strainers shall be provided with blow down ball valve with cap and chain.
- C. Upon completion of piping system flushing and cleaning, the contractor shall remove all strainer start-up screens/strainers and secure each to the associated strainer until the commissioning agent or engineer can confirm their removal.

SECTION 23 0553

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the identification requirements for the mechanical systems.
- 1.2 RELATED SECTIONS
 - A. Section 23 0010 General Provisions HVAC
 - B. Section 23 0500 Common Work Results for HVAC Systems
 - C. Section 23 2113 Hydronic Piping

1.3 SUMMARY

- A. Section includes:
 - 1. Plastic Coiled Pipe Markers.
 - 2. Pressure Sensitive Adhesive Pipe Markers.
 - 3. Underground Warning Tape.
 - 4. Valve Tags and Schedules.
 - 5. Engraved Plastic Signs.
 - 6. Engraved Equipment Markers.

1.4 REFERENCES

- A. American National Standards Institute (ANSI): ANSI A13.1-1985–Scheme for the Identification of Piping Systems.
- B. Department of Labor 29 CFR 1910.1200.

1.5 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Product Data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.
- C. Schedules: Submit valve schedule for each piping system, typewritten and produced on 8½" x 11" bond paper. Include valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and any variations for identification. If addition to framed copies, furnish extra copies for maintenance manuals as specified in Division 1.

1.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of identification products of types and sizes required, whose products have been in satisfactory use for a period of five (5) years.
- B. Codes and Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification products.

PART 2: PRODUCTS

- 2.1 MECHANICAL IDENTIFICATION MATERIALS
 - A. Provide manufacturer's standard products for each application as referenced in this section.
- 2.2 PIPE MARKERS
 - A. Pressure-Sensitive Type: Provide manufacturer's standard preprinted, permanent adhesive, color-coded pressure sensitive vinyl labels complying with ANSI A13.1. Color-coded plastic adhesive flow directional arrow tape, full circle at both ends of the pipe marker, tape overlapped 1-1/2". Use 1" tape for piping less than 2-1/2", 2" tape for 2-1/2" thru 8" piping; and 4" tape for larger piping.
 - B. Lettering: Comply with ANSI A 13.1 for piping system nomenclature. Abbreviate only as necessary to accommodate marker length.

2.3 VALVE TAGS

- A. Plastic Tags: Provide manufacturer's standard 1/16" plastic engraved tags, 1½" square, black with white lettering, with ¼" high service indicator on top line and ½" numbers below.
- B. Valve Tag Fasteners: Use solid brass "S" hooks for installation of valve tags.
- C. Chart Frames: Provide one (1) aluminum 8 ¹/₂" x 11" valve chart frame with glass lens for each valve schedule provided.
- D. Access Panel Markers: Provide manufacturer's standard 1/16" thick engraved plastic access panel markers with abbreviations and numbers corresponding to the concealed valve.

2.4 ENGRAVED PLASTIC EQUIPMENT MARKERS

A. Provide manufacture's standard 1/16" engraved equipment tags matching the terminology on schedules as closely as possible. Use black with white letters, $1" \times 3"$ or $1 \frac{1}{2}" \times 4"$ for control devices and small equipment and valves and $4" \times 6"$ for large equipment. Use black with white letters, 3" long x the ceiling grid width for equipment above lay-in ceilings.

PART 3: EXECUTION

3.1 GENERAL INSTALLATION REQUIREMENTS

A. Where identification is to be applied to surfaces requiring painting, insulation, or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.2 MARKER LOCATION

A. Install pipe markers on each system indicated, include arrows showing normal direction of flow.

- C. Locate pipe markers and/or color bands (if required) wherever piping is exposed to view, and at least one marking per room above suspended ceilings. Per the following:
 - 1. Near each valve and control device.
 - 2. Near each branch, excluding short take-offs for fixtures and terminal units mark each branch where there might be a question of flow direction.
 - 3. Near locations where pipes pass through walls, floors, or ceilings or where they enter non-accessible locations.
 - 4. Behind removable panels and other access points permitting view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. On piping above removable acoustical ceilings.
 - 7. At maximum intervals of 40' along each straight pipe run, except to 25' in congested areas.

3.3 VALVE IDENTIFICATION

A. Provide a valve tag on every, cock, and control device in each piping system. Exclude check valves and valves within factory fabricated equipment units,. List each tagged valve in a valve schedule for each piping system.

3.4 EQUIPMENT IDENTIFICATION

- A. Install engraved plastic signs or equipment markers on or near each major item of mechanical equipment and each operational device, per the equipment schedule. Attached tag to the ceiling grid directly under equipment installed above lay-in ceilings. Provide markers for the following general categories of equipment and operational devices.
 - 1. Main control and operating valves including safety devices and hazardous units.
 - 2. Meters, gauges, thermometers, and similar units.
 - 3. Fuel burning units including boilers, furnaces, heaters, stills, and absorption units.
 - 4. Pumps, compressors chillers, condensers, and similar motor driven units.
 - 5. Heat exchangers, coils, evaporators, cooling towers, heat recovery units, and similar equipment.
 - 6. Fans, blowers, primary dampers, and mixing boxes.
 - 7. HVAC central station and zone units.
 - 8. Tank and pressure vessels.
 - 9. Strainers, filters, humidifiers, water treatment systems, and similar equipment.
- B. Method of Installation: Use stainless steel screws except where adhesive is necessary because substrate cannot or should not be penetrated. Use rivets for tags attached to the ceiling grid.

SECTION 23 0593 TESTING, BALANCING, AND ADJUSTING

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the requirements for testing and balancing the Heating, Ventilating, and Air Conditioning Systems.
- 1.2 RELATED SECTIONS
 - A. Section 01 9113 General Commissioning Requirements
 - B. Section 23 0010 General Provisions HVAC

1.3 QUALIFICATIONS

A. The test and balance work shall be performed by an independent firm certified by the Associated Air Balance Council (AABC), or National Environmental Balancing Bureau (NEBB). <u>The test and balance firm shall be Air Analysis and shall be procured directly by Emory University.</u>

1.4 PROCEDURES

- A. All air distribution systems and hydronic systems shall be tested, adjusted, and balanced to the conditions specified and/or shown on the drawings.
- B. Performance of systems and components at specified conditions shall be verified by testing.
- C. Before request for final inspection, calibrate, adjust, set, test and check all valves, dampers, temperatures, pressures, and flow rates of systems for operation and performance.
- D. All test and balance work shall be performed in accordance with AABC or NEBB procedures.
- E. Review the proposed systems installation drawings and determine if all measuring and balancing devices required for proper test and balance of the systems are specified and sized correctly.
- F. Check that proposed ductwork layouts allows duct pitot traverses to be performed correctly to allow overall air flows.
- G. The Test and Balance contractor shall read and implement the Test and Balance Plan of Action shown below.

1.5 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide Test and Balance Plan of Action as specified in Part 3 of this section. A detailed balancing plan shall be submitted for all projects at the same time as mechanical submittal data.

1.6 REPORTS

A. Submit completed and certified report to Architect in triplicate or in printable electronic format.

PART 2: PRODUCTS

- 2.1 GENERAL
 - A. Provide all instruments, charts, materials, and equipment required to develop a complete test and balance report.

PART 3: EXECUTION

- 3.1 TEST AND BALANCE REPORT
 - A. Test and balance report shall be a complete document, not limited to, but including at least the following:
 - 1. Air side of systems:
 - a. Coil entering and leaving temperatures.
 - b. All air unit component pressure drops.
 - c. Fan RPM and entering and leaving static pressure.
 - d. Air flow readings for all diffuser outlets and exhaust grilles.
 - e. Air flow and pressure drops for all terminals. Where heating coils are included, data shall be same as under Coils and Heat Exchangers.
 - f. Space temperatures at thermostats.
 - g. Outlet temperatures of selected diffusers.
 - 2. Coils, Pumps and Heat Exchangers:
 - a. Entering medium temperature, flow rate, and pressure.
 - b. Leaving medium temperature, flow rate, and pressure.
 - 3. Electric Motors:
 - a. Full load amperes, voltage, and horsepower.
 - b. Installed starter heater size.
 - 4. Fire Dampers: At selected dampers, blades will be dropped to prove close-off without binding.
 - 5. Fire/Smoke Dampers: Provide operation of all dampers on activation of smoke detectors or fire alarm signal.
 - 6. HVAC Equipment P-traps
 - a. Verify that P-traps are installed to manufacturer's requirements with respect to balanced system static pressure(s) and respective required heights, lengths, and slopes.

- 7. Controls:
 - a. Calibrate all control elements and check operation including all interlocks.
 - b. Aide in adjusting all control systems to optimize energy use for all associated equipment.
 - c. Coordinate, aide and verify in located of sensors and to help ensure that sensor locations shall be free from drafts, heat sources or other factors that may affect the accuracy of the control system. Coordinate any change in sensor location with engineer prior to commencing work.
- B. Total Systems: Contractor shall check all systems operating together, in all modes of operation, to ensure that the air conditioned spaces are in an overall positive pressurization state.
- C. General: Report shall include a list of all deficiencies found during the preliminary testing and a contractor response indicating remedial action taken for each item. The TAB work shall not be deemed finished without this report.

3.2 BALANCING AND ADJUSTMENT AFTER FINAL INSPECTION

- A. After building is accepted and occupied, and after testing and preliminary balancing are completed, send qualified personnel to building for not less than one period during summer and one period during winter, observe temperatures throughout conditioned spaces, consult with Owner's representative as to need for additional balancing or adjustment, then perform such work as is indicated. The test and balance activities performed for the preliminary TAB shall not be considered a seasonal TAB.
- B. Schedule these visits, at a time agreeable to Owner, during December through February for heating, and July through August for cooling. The summer seasonal TAB should be performed while occupied during near peak seasonal conditions with minimum and maximum OA temperatures specified for summer and winter TABs.
- C. Notify the owner at least a week in advance of the seasonal TABs requesting that the filters be clean prior to the TAB and all the systems will be ready and operational for the seasonal TAB.

3.3 TEST AND BALANCE PLAN OF ACTION

- A. The general contractor shall incorporate the TAB into the overall construction project to ensure that enough time is allowed for the testing and balancing contractor to complete the total system balancing according to a balancing plan prior to the completion date defined by the construction schedule. Final TAB shall be complete a minimum of 2 weeks prior to Substantial Completion unless otherwise approved by the Owner.
- B. TAB shall not be started until the building envelope is completed, ceilings installed, interior and exterior doors and windows are in place.
- C. A balancing plan prepared by the balancing contractor shall cover balancing techniques and testing procedures for all individual systems and equipment as well as for the overall system.

- 1. The plan shall include:
 - a. A list of the test instruments that are planned to be used in the testing and balancing process.
 - b. A description of the testing procedure for each HVAC system to be tested. List all of the equipment to be tested for each system and the techniques to be used for the testing procedure. Standard forms used by the TAB agency association shall be completed to reflect all equipment and systems identified by system and/or model number specific to the project. Blank, "sample" forms are unacceptable.
 - c. A list of the all contractors that are required to assist with the testing and balancing process along with the expectations of each of the contractors to successfully complete a total system balance. Most importantly, the expectations of the BAS contractor shall be listed. This shall include provision of automation software for balancing, timely automation system access, and the development of global overrides for system maximum performance testing.
 - d. The TAB contractor shall review the mechanical and architectural drawings and shall verify if all devices and components required to balance the systems are provided and are accessible. TAB contractor shall notify the engineer, architect and general contractor of any conflicts that may prohibit them from completing their scope of work.
 - e. An outline of the required construction completeness prior to <u>starting</u> the testing and balancing process
 - f. A realistic estimate of the time required to complete the testing and balancing process; the plan shall describe in detail the required time to complete balance of sub-systems and total system balance. The general contractor shall recognize that the balancing process sequential and not a process that can be shortened by simply putting more technicians on the project to complete the process faster. Buildings with direct digital control systems require a great deal of the testing and balancing process to be performed through adjustments to the HVAC systems via the automation/control system. Network access limitations and/or control software may prevent more than one operator from communicating with the automation/control system at a time. This makes it inefficient to have too many balancing technicians on a single project if the majority of the adjustments can only be made through one computer terminal.
 - g. A listing of the necessary uninterrupted accessibility to the building to completely test HVAC equipment and sub systems.
 - h. The general contractor shall allow time in the balancing plan schedule to allow the balancing contractor to address any issues in the design or installation, which prevents a system from operating at design performance. The general contractor shall take the time for resolution of these issues by the responsible party into account in the balancing schedule. A 'contingency' of an additional week or two should be incorporated into the balancing plan schedule to accommodate additional time required for the responsible party to correct any minor issues preventing design performance of the building.

- i. Building accessibility during balancing
 - (1) The balancing contractor shall be provided uninterrupted access to all areas of the building. Large HVAC systems may require the access to the same area several times throughout the balancing process. Finishing processes of the building construction such as laying carpet and tile flooring, waxing floors, construction cleaning, and fire alarm testing that require the HVAC systems to be shut down shall be identified in the balancing plan to inform the construction manager of possible conflicts who shall attempt to schedule the testing and balancing process around them. Some building accessibility issues to address in the balancing plan include the following:
 - i. Flooring work, such as carpet laying and tiling, must be performed either before or after the testing and balancing process for a particular system serving the area in which the flooring work is to be done. If the completed flooring will restrict the use of boom lifts, the testing and balancing of the system serving that area shall be completed before the floor work if the HVAC system components are inaccessible by ladder.
 - ii. Final building cleaning that would prevent further access of contractors shall be delayed until the testing and balancing is completed.
 - iii. If fire alarm testing will affect the HVAC system, the balancing contractor should be notified in advance when fire alarm testing is scheduled. For example, closing fire dampers or shutting down air handling units can disrupt total system balancing.
- D. A detailed balancing plan shall be submitted for all projects at the same time as mechanical submittal data. The balancing contractor shall follow up with the general contractor to ensure that the balancing plan has been properly reviewed and incorporated within the construction schedule.

3.4 COMMISSIONING REQUIREMENTS

- A. The contractor shall provide a minimum of three days notice to schedule the Commissioning Agent to be on site during all Testing and Balancing activities.
- B. The contractor shall submit a "Test and Balance Execution Plan" indicating their overall schedule for waterside and airside equipment work with descriptions of their balancing procedures for approval by the Engineer and Commissioning Agent a minimum of one (1) month prior to starting any field work.
- C. Contractor shall be on site during the commissioning Acceptance Testing Phase prior to building occupation, during the Warranty Phase's two (2) HVAC system commissioning off-season tests (August afternoon and January), and during the commissioning 10 month warranty site visit for re-commissioning.

SECTION 23 0700 HVAC INSULATION

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. Insulation specified in this Section is for insulation used in Division 23 work.
- 1.2 RELATED SECTIONS
 - A. Section 23 0010 General Provisions HVAC
 - B. Section 23 2113 Hydronic Piping
 - C. Section 23 2114 Hydronic Water Specialties

1.3 DEFINITIONS

- A. Exposed piping and ductwork is work that can be seen when the building is complete without opening or removing access doors or panels.
- B. Other piping and ductwork is considered to be concealed.

1.4 INSPECTION

- A. Surfaces to be insulated shall be clean, dry, and free of foreign material, such as rust, scale and dirt when insulation is applied. Perform pressure tests required by other Sections before applying insulation.
- B. Where existing insulation is damaged due to the new work, repair damage to match existing work or replace damaged portion with insulation specified for new work.

1.5 QUALITY ASSURANCE

- A. Products of the manufacturers listed will be acceptable for use for the specific functions noted. All materials shall be compatible with the materials to which they are applied, and shall not corrode, soften or otherwise attack such material in either the wet or dry state.
- B. Materials shall be applied subject to their temperature limits. Any methods of application of insulating materials or finishes not specified in detail herein shall be in accordance with the particular manufacturer's published recommendations.
- C. Insulation shall be applied by experienced workers regularly employed for this type work.

1.6 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide data on each insulation type including, but not limited to, application, material, finish, thickness, density, operating temperature range, mean thermal conductivity and related temperature, and jacketing if specified.
- C. Provide manufacturer's instructions indicating installation and support requirements.

1.7 RATING

- A. Insulation and accessories, unless specifically exempted, shall have a composite flame-spread rating of not more than 25 and a smoke developed rating of not more than 50. Materials that are factory applied shall be tested as assembled. Materials that are field applied may be tested individually. No fugitive or corrosive treatments shall be employed to impart flame resistance.
- B. Flame Spread and Smoke Developed Ratings shall be determined by Method of Test of Surface Burning Characteristics of Building Materials, ASTM E-84 1997 or U.L. 723.
- C. Products or their shipping cartons shall bear a label indicating flame spread and smoke developed ratings.
- D. Treatment of pipe jackets and duct facings to impart flame and smoke safety shall be permanent.

1.8 STORAGE

- A. All insulation materials stored on site shall be located in a clean, dry area and protected from moisture damage.
- 1.9 ASBESTOS
 - A. All materials used in this work shall be asbestos free.

PART 2: PRODUCTS

- 2.1 INSULATION APPLICATIONS
 - A. Duct Insulation Denoted by Type D:
 - 1. Interior Supply and Outside Air ductwork:
 - a. Type D1 Glass fiber, flexible, 2" thick.
 - B. Pipe Insulation Denoted by Type P:
 - 1. Interior Hydronic heating water piping in building:
 - a. Type P3 Glass fiber, rigid, 1" thick for piping up to 2" diameter and 2" thick for piping larger than 2" diameter.
 - 2. Interior Condensate piping from coils and heat exchangers:
 - a. Type P8 Elastomeric tube, 3/4" thick.

2.2 ACCESSORY MATERIALS

- A. Low VOC adhesives, sealants and mastics shall be selected as recommended by the insulation manufacturer. Adhesives shall be water based, and must comply with the current VOC content limits of the South Coast Air Quality Management District (SCAQMD) Rule #1168, with a maximum VOC emission of 70 grams per liter. Low VOC water based sealants and mastics shall be manufactured to comply with NFPA 90A, U.L. listed and complying with ASTM E84 and comply with the current VOC limits of the SCAQMD Rule #1168, with a maximum VOC emission of 250 grams per liter. They shall be manufactured by the insulation manufacturer or by Foster, Flintkote, Hardcast, Insul-Coustic, Lion Oil or 3M.
- B. Adhesives, sealants and mastics which secure a vapor barrier material shall be of the vapor barrier type.
- C. Adhesives, sealants and finishes for surfaces above 70°F shall be of the "breather" type.
- D. Insulation jackets shall have a vapor barrier when applied to surfaces subject to sweating in an ambient environment up to 90°FD.B. and 80°FW.B.; including chilled water, condensate drain, and refrigerant suction.
- E. Where specified, finish jackets for all insulation in the building shall be not less than 8 oz./sq. yd. white, pre-sized glass cloth kraft paper reinforced by Carolina or Twinsburg-Miller.
- F. All finish mastics and sealants shall be white in color, unless noted otherwise.
- G. Staples shall be "outward clinch" or "flare" type.
- H. Galvanized steel wire shall be 20 gauge.
- I. Stainless steel wire shall be 20 gauge.
- J. All Valves, Strainers, Circuit Setters and any combination fitting of these shall be insulated with "No Sweat" Reusable Valve Wraps.
- K. Ductwork manual volume damper (MVD) handles, airflow station pressure ports, access door handles, duct-mounted instrumentation, etc. shall be left exposed and / or accessible above the insulation vapor barrier to enable the TAB agency or engineering maintenance personnel to access, adjust and / or read these devices without disturbing the integrity of the insulation vapor barrier.

2.3 INSULATION PIPE SHIELDS

A. Shields shall be galvanized rolled to form a 180° arc. Length of shields shall conform to the following:

Insulation O.D.	Shield Length	Shield Gauge
0-4 inch	12 inch	14 gauge
5-9 inch	18 inch	14 gauge

2.4 INSULATION DESIGNATION

A. Type D1 shall be Glass Fiber Insulation, flexible, suitable for interior application.
- Insulation shall be composed of one lb./cu.ft. density glass fibers bonded with a thermosetting resin. Operating temperature range shall be 40°F to 250°F. Mean thermal conductivity shall not exceed 0.27 at 75°F. Manufacturers shall be Certainteed, Knauf, Owens Corning, or Schuller (Manville).
- 2. Insulation finish shall be factory applied foil/scrim reinforced kraft (FSK) jacket with longitudinal flap for butt joint closure. Jacket permeance shall not exceed 0.02 perms.
- B. Type P3 shall be Glass Fiber Insulation, suitable for interior application.
 - 1. Insulation shall be composed of high-density glass fibers bonded with a thermosetting resin. Operating temperature range shall be 0°F to 850°F. Mean thermal conductivity shall not exceed 0.23 at 75°F. Manufacturers shall be Certainteed, Knauf, Owens Corning, or Schuller (Manville).
 - 2. Insulation finish shall be factory applied all service jacket with pressure sensitive adhesive closures for the longitudinal and butt joints. Jacket permeance shall not exceed 0.02 perms.
 - 3. All valves, thermometer wells, gauge cocks, hose bibbs, air vent piping, and any other components shall be insulated with molded insulation fittings or same thickness elastomeric insulating tape finished with flexible glass cloth and mastic. Use of PVC covers with loose fiberglass fill is not acceptable.
- C. Type P8 shall be Elastomeric Insulation, suitable for interior application.
 - Elastomeric tube and tape shall be a closed cell rubber material with a minimum density of 3.0 lbs./cu.ft. Operating temperature range shall be -70°F to 180°F, with a mean thermal conductivity of 0.27 at 75°F. Material shall have a water vapor permeability not exceeding 0.08 perm-inch, and shall resist mildew development. Flame spread rating shall not exceed 25 and smoke developed rating shall not exceed 50. Manufacturers shall be Armacell (Armaflex) or Rubatex.
 - 2. Provide PVC jacket on insulation where piping is exposed to building occupants. Protective jacket shall be paintable white PVC, high impact type, UV resistant, flame spread and smoke developed 25/50 rated per ASTM E 84 and shall have minimum 0.020" thickness.

PART 3: EXECUTION

- 3.1 GENERAL APPLICATION
 - A. The following general conditions apply to the insulation installation.
 - 1. Insulation shall be clean and dry during installation and during application of any finish.
 - 2. Provide removable and replaceable covers on all pumps and equipment requiring insulation that must be opened periodically for inspection, cleaning, or repair.
 - 3. Install insulation, jackets, and coatings continuous through wall and floor openings and sleeves. See Section 23 05 00 regarding fire barrier sealing over insulated pipes passing through rated floors and walls.
 - 4. Banding wires shall have the twisted terminals turned down into the insulation, except where vapor barrier would be punctured.
 - 5. Finish open ends of pipe insulation as specified for fittings.
 - 6. All piping, ductwork, and equipment which are scheduled to be insulated shall have a finished jacket, either factory or field applied.

- 7. Staples shall be installed only on insulation that does not contain a vapor barrier.
- 8. For all cold piping systems (chilled water, condensate, and domestic cold water), all components of the piping system shall be insulated and provided with a continuous vapor barrier. Vapor barriers shall be continuous for entire piping system and shall not be pierced except as specified otherwise.
- 9. Factory applied jacket shall be the finish jacket unless otherwise noted.
- 10. Maintain vapor barrier where dissimilar insulation products abut.
- 11. Lined ductwork is not required to be insulated externally. Where lined and insulated duct meet duct, liner shall overlap, minimum 4".
- 12. Control devices shall be installed on the outside surface of insulation except devices such as firestats. All resulting penetrations and edges of insulation shall be sealed as specified above.
- 13. No insulation materials shall be in direct contact with supply, return or exhaust airstreams.
- 14. Install "No Sweat" Reusable Valve Wraps per manufacturers recommendations.

3.2 PIPE SHIELDS

- A. For all piping, insulation shall be continuous on pipe at pipe hangers with protection shields bearing on the outside of the insulation.
- B. For pipes 2" and larger, where insulation would be crushed by hangers, provide 180 degree foamed glass inserts between pipe and hanger protector and finish with jacket same as adjacent pipe.

3.3 INSULATION APPLICATION

- A. Type D1 Glass Fiber, flexible Insulation:
 - 1. Blanket insulation shall be installed with not less than one inch (1") of insulation cut back from the edge of vapor barrier. Vapor barrier shall then overlap the adjacent insulation and vapor barrier at each and every abutting joint. Overlaps shall be sealed with adhesive. In addition, all joints in the vapor barrier such as at hangers and supports shall be sealed with aluminum foil tape.
 - 2. All blanket insulation shall be held in place with adhesive 3" wide at not over 12" intervals.
 - 3. Where duct greatest dimension is more than 24-inches but less than 48 inches, insulation shall also be tightly wrapped with galvanized wire, 24" on center. Where duct greatest dimension is more than 48-inches, 2" wire mesh shall also be secured to the duct with mechanical fasteners at not more than 2'-0" center to center in two directions.
- B. Type P3 Glass Fiber Insulation:
 - 1. Cover pipe with insulation with each section tightly abutted one to another. Jacket shall be lapped and secured with self-adhesive strip.
 - 2. Abutting ends of insulation shall be covered with 4" wide butt strips smoothly secured with adhesive.
 - 3. Fittings and valves shall be covered with mitered or molded insulation sections secured with galvanized steel wire and finished with smooth coat of white glass fabric and mastic. PVC fitting covers shall not be used.
- C. Type P8 Elastomeric Insulation:

- 1. Slip piping insulation on before joints are made up. Butt joints together and seal with manufacturers adhesive.
- 2. Insulate fittings and valves with miter cut pieces of insulation the same thickness as the piping insulation.

3.4 FINISH JACKETS

- A. Field installed jackets shall be provided when specifically noted.
- B. Pre-sized glass cloth jackets shall be secured by a continuous coating of adhesive applied to a uniform thickness. Jacket shall be smooth without wrinkles. Jacket shall be applied to straight lengths of covering only.
- C. Flexible glass cloth shall be applied to equipment, valves, fittings, and curved surfaces. Cloth tape shall be smoothly applied and secured with a continuous coat of adhesive. White fabric and mastic to be used on exposed pipe fittings. Tape shall overlap itself and adjacent jackets not less than two inches (2").

SECTION 23 0933 AUTOMATIC CONTROLS SYSTEM

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the requirements for the Automatic Control system, which shall be an extension of the existing Direct Digital Control System by Automated Logic (ALC)
- 1.2 RELATED SECTIONS
 - A. Section 23 0010 General Provisions HVAC
 - B. Section 23 0100 Operation and Maintenance of HVAC Systems
 - C. Section 23 0500 Common Work Results for HVAC
 - D. Section 23 0553 Identification for HVAC Piping and Equipment

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Submittals shall include a proposed wiring diagram with accompanying typewritten sequence of operations. A symbols list defining all abbreviated components shall be included. A cut sheet on each component used in the system shall be included.
- C. Separate wiring diagrams shall delineate between power and control wiring and shall indicate all starters, contactors, relays, thermostats, time clocks, and other components of the system. Normally open positions for valves, dampers, and relays shall be indicated.
- D. A copy of the record control diagram shall be mounted, framed and covered, adjacent to the control panel.
- E. Provide manufacturer's instructions, indicate installation and support requirements.
- F. Provide operation and maintenance procedures; include start-up instructions, assembly drawings and parts list.

1.4 RELATED WORK

A. Power wiring is specified under another Division. This section defines the requirements for control wiring to provide interlock and sequence of operation for various portions of the control system.

1.5 QUALITY ASSURANCE

A. Control installation work shall be performed by mechanics regularly employed in the installation of control systems. Control devices shall be Johnson Controls, Robertshaw, Barber Coleman, or Honeywell. All control devices shall be by one manufacturer.

PART 2: PRODUCTS

- 2.1 SENSING/CONTROL FIELD DEVICES
 - A. Temperature Sensors:
 - 1. Sensors shall be platinum, 1000 ohms RTD, accurate to plus or minus 0.5°F between the range of 0°F to 100°F.
 - 2. Sensors shall be encapsulated in epoxy with a stainless steel or copper sheath.
 - B. Temperature Transmitters shall have elements suitable for immersion into piping and have platinum RTD for use with bridge circuit controllers or transmitters. Sensors to be single, dual, averaging, dual wound or suitable to maintain stable control. Provide stainless steel immersion wells with heat conducting compound in piping. Minimum range shall be -30°F to 240°F.
 - C. Pressure Transmitters: Provide an electronic device with pressure ranges from -30" Hg to 400 psig that generates a 4 – 20 ma signal, suitable for gaseous or water applications. Device shall be housed in a watertight polystyrene enclosure. Device shall be suitable for temperature ranges of -12°F to 167°F. Device shall be provided with a pressure gauge in a corresponding pressure range.
 - D. Water Directional Flow Transmitters shall be insertion type with contra-rotating dual turbines for bi-directional flow sensing, in-stream type with nickel plated brass wetted components, electronic impedance sensing and 2% accuracy as manufactured by Onicon. Device shall be fitted with hot tap adapter and proper stem length. Minimum range shall be 30° to 180°F.

2.2 CONTROL DAMPERS (AIRFOIL TYPE – OPPOSED ACTION)

- A. Control dampers shall be multi-blade, opposed action, airfoil type. Frames shall be formed 16-gauge galvanized steel channel with corner braces. Maximum individual damper width shall not exceed 60". Blades shall be double skin airfoil type, 6" (maximum) wide, constructed of 16 U.S. Gauge (minimum thickness) formed galvanized steel attached to cold-rolled galvanized steel axles. Axle bearings shall be self-lubricating nylon or Teflon. Damper shall be controlled by factory assembled operating linkages concealed in the frame outside of airstream, constructed of galvanized steel. Jamb seals shall be stainless steel and blade seals shall be compressible neoprene, synthetic elastomer or extruded vinyl. Blade seals shall be replaceable. Leakage rate shall be AMCA certified. Individual actuators shall serve a maximum of 30 square feet of damper area. Provide additional actuators for larger areas. Dampers shall be powered closed and foil-open. Ruskin CD60 or equal by Arrow United, Cesco, Greenheck, or National Controlled Air.
- B. Motorized Control Dampers to be installed by the mechanical contractor.

2.3 MISCELLANEOUS DEVICES

- A. Current Switches shall be solid state switch with adjustable setpoint (set at no load condition for pump run status). Switch capacity shall be selected based on motor monitored.
- B. Electric actuators shall either be push-pull magnetic or hydraulic type, or rotary (geartrain) type for two-position or modulating service as required by application. All electric actuators shall be UL listed with NEMA 1 enclosures, unless otherwise acceptable.

- C. Control Relays: Interposing control relays shall be rated for the application, have a minimum of two (2) sets of Form C contacts, and be enclosed in a dustproof enclosure. The coils shall be equipped with transient suppression devices to limit transients.
- D. Boiler Emergency Power Off Switches shall be push-button type with "hold" on depression of button for boiler-stop and requiring turn-and-push for release of boiler-stop position. Furnish a hinged Plexiglass cover over the switch to prevent accidental switching. Provide labeling of the switch. Colors shall be red with white letters.

2.4 CONTACTORS

A. Contactors shall be magnetic designed for resistance heating and tested for 100,000 cycles. Contacts shall be silver alloy. Enclosure shall meet the requirements of U.L. 508 with NEMA Type 1 indoors. Provide one set of auxiliary contacts and control transformer with fused, grounded secondary. Holding coil voltage shall not exceed 120 volts.

2.5 RELAYS

A. Relays shall include silver-alloy contacts rated for the branch circuit served, mechanically held, number of poles as required, plug-in style with a separate base with wiring terminated to the base, NEMA 1 enclosure inside, maximum holding coil voltage of 120 volts. Relays shall not be used for staging of output sequences specified for the DDC automatic control system.

2.6 WIRING

- A. Sensor and Communications Wiring: All sensor and communications wiring shall be copper, not less than #18, color coded, twisted pair, shielded if required for proper system operation.
- B. Line Voltage Wiring: Shall be minimum #12, 600 volt rated, THHN, color-coded and installed as specified under Division 26.

2.7 LABELS

A. Label control apparatus with engraved laminated bakelite labels, bearing functional designations as shown on the control diagram.

PART 3: EXECUTION

- 3.1 INSTALLATION GENERAL
 - A. Label control apparatus with nameplates or tags bearing the functional designations shown on approved control diagrams.
 - B. Wiring Installation:
 - 1. All line voltage serving the Automatic Control System shall be run in conduit or EMT, installed per Division 26 requirements.
 - 2. All control wiring shall be routed in conduit and shall not have any other type of wiring (power, etc.) routed in the same conduit.

3.2 GRAPHICS MODIFICATIONS

- A. The existing on-screen graphics at the associated Central Station for all existing mechanical systems modified under the scope of work of this project shall be revised to incorporate the modifications and additions to these mechanical systems:
- B. Sequence of Operation Text: For each piece of new, controlled equipment or revised, controlled equipment provide a sequence of operation.
- 3.3 SEQUENCES OF CONTROL
 - A. Refer to the Drawings for Sequences of Control.
- 3.4 START-UP AND CHECK-OUT
 - A. Manufacturer's representative shall start-up and check-out all control systems and components and successfully demonstrate their operation for a period of at least 24 hours. All control valves, and actuators shall be adjusted for proper setpoints and operation. Notify the Engineer when start-up and check-out are completed successfully.
- 3.5 OPERATOR INSTRUCTION AND TRAINING
 - A. Provide written notice to the Owner when the controls system is requested to be turned over to the Owner.
 - B. Provide training of the Owner's personnel on the control system:
 - 1. On-site orientation at a date and time as requested by the Owner's Representative and provided by a field engineer who is fully knowledgeable of the specific installation details of the project. On-site orientation shall include a walk-through of the facility to identify panel and device locations.
 - 2. Provide a total of two (2) man-hours of instruction time at a date and time as requested by the Owner's Representative. This orientation shall, at a minimum, consist of a review of the project as-built drawings, software, including sequences of control, and naming conventions.

SECTION 23 2000 PIPE, FITTINGS AND ACCESSORIES – HVAC

PART 1: GENERAL

- 1.1 DESCRIPTION
 - Piping specified in this Section is for types of pipe and accessories used in Division 23.

1.2 RELATED SECTION

A. Section 23 0500 Common Work Results for HVAC.

1.3 QUALITY ASSURANCE

- A. Pressure piping systems shall meet requirements of the ASME and ANSI Standards B31.1 Power Piping and B31.9 Building Services Piping, and all addenda.
- B. Codes and regulations referred to are minimum standards. Where the requirements of these specifications or drawings exceed those of the codes and regulations, the drawings and specifications govern.
- C. Pressure/temperature ratings of all components and accessories shall meet or exceed design conditions for the system in which they are installed.
- D. Welding shall be in accordance with procedures of the National Certified Pipe Welding Bureau and shall comply with the requirements of the ANSI Code for Pressure Piping. Welders shall be qualified under the above procedures and certified by the National Certified Pipe Welding Bureau.

PART 2: PRODUCTS

2.1 PIPE AND FITTINGS

A. Steel Piping:

Pipe (up to 12" diameter):		
Material	Specification	
Schedule 40 Black steel	ASTM A53-97b Grade B	
Schedule 80 Black steel	ASTM A53-97b Grade B	
Schedule 40 Galvanized steel	ASTM A53-97b	

- 2. Fittings:
 - a. 150 lb. SWP malleable iron screwed fittings conforming to ANSI B16.3.
 - b. 125 lb. SWP cast iron flange fittings conforming to ANSI B16.1.
 - c. Standard weight factory fabricated butt welding fittings conforming to ANSI B16.9 and ASTM A-234.
 - d. 150 lb. forged steel welding neck or flat face slip-on flanges conforming to ASTM A181.
 - e. Socket fittings conforming to ANSI B16.11.

- f. Cast iron drainage pattern fittings conforming to ANSI B16.12.
- g. Dielectric couplings and/or flange kits shall be provided at connections between ferrous and non-ferrous pipe. Provide with high temperature gaskets rated for 300°F steam service.
- h. Unions:
 - (1) Except where otherwise specified, unions in welded piping shall be flanges.
 - (2) Unions in piping 2-inch and smaller shall be 150 lb. malleable iron, ground joint, bronze to iron, screw type.
 - (3) Unions in screwed piping 2¹/₂" and larger shall be 125 lb. cast iron flanges.
- i. Fittings, flanges and unions in galvanized steel pipe shall be galvanized.
- 3. Joints, unless specified otherwise:
 - a. Screwed Joints: Joint compound shall be "Titeseal" or Teflon Tape, except where otherwise specified.
 - b. Welded Joints: Welding rods shall be compatible with the material to be welded. Welding shall be by electric arc or oxyacetylene methods.
 - c. Flanged joints shall be made up with 1/16" thick, ring type, compressed composition sheet gasket, except for gas piping which shall be made up with aluminum "O" ring type gaskets. Flange bolts shall be steel hexagon head type, conforming to ASTM Specification A-307. Nuts shall conform to ASTM Specification A-193.
- B. Copper Piping:
 - 1. Pipe:

Material	Specification
Type L tube	ASTM B88-99
Type K tube	ASTM B88-99

- 2. Fittings:
 - a. Wrought copper solder joint type conforming to ANSI B16.22. Cast fittings conforming to ANSI B16.18, except where otherwise specified, may be used only in patterns not available in wrought fittings, and where desired changes in direction and/or reduction in size cannot be accomplished with two wrought fittings.
 - Adapter fittings shall be provided at all copper to brass pipe connections. Adapters 2" and smaller shall be cast bronze or wrought copper. Adapters larger than 2" shall be 150 lb. cast bronze flanges. Adapters between the meter and the pressure reducing valve shall be 250 lb cast bronze flanges.
 - c. 150 lb. cast bronze flange fittings conforming to ANSI B16.24 downstream of the pressure reducing valves.

- d. Dielectric couplings and/or flanged kits shall be provided at all copper to steel pipe connections.
- e. Unions:
 - (1) Except where otherwise specified, unions shall be wrought copper or cast bronze.
 - (2) Unions in piping 2¹/₂" and larger shall be 150 lb. cast bronze flanges, downstream of the pressure reducing valve and 250 lb between the meter and the PRV.
 - (3) Insulating unions shall be provided at all equipment having ferrous connections.
- 3. Joints, unless specified otherwise:
 - a. Solder Joints: Solder shall be 95/5 (95% tin, 5% antimony) except where otherwise specified. Where specified or noted on the drawings, solder shall have a silver alloy solder having a melting point of not less than 1100°F. NO LEAD SOLDER SHALL BE PERMITTED.
 - Solder flux shall be the type recommended by the manufacturer of the 95/5 solder used, meeting ANSI/NSF Standard 61. Silver brazing flux shall be used for solder of 1100°F. or higher melting point.

2.2 SLEEVES

- A. Provide standard weight steel pipe sleeves at all points where piping passes through walls, floors and ceilings, except where otherwise specified.
- B. #20 U.S. gauge galvanized steel sleeves may be used through all walls and through floors in concealed pipe chases where concrete thickness is 4" or less.

PART 3: EXECUTION

- 3.1 PIPING GENERAL
 - A. All piping shall be run straight and parallel to building construction. All changes in directions shall be made with fittings as specified herein and shown on the drawings.
 - B. All piping shall be installed with allowance for expansion and contraction. Anchors and guides shall be provided where shown on the drawings. Swing joints shall be provided at top and bottom and risers and in branch connection at each floor.
 - C. Pipe connections to equipment which is supported independent of the pipe, including pumps, shall be aligned with the equipment.
 - D. Buried piping outside the building shall be buried a minimum of 24-inches deep.
 - E. Install piping so as to preserve access to all valves, air vents, and other equipment and to provide the maximum headroom possible.
 - F. All piping, except cast iron, which runs through concrete slabs or walls shall be insulated or caulked in sleeves as hereinafter specified so that the pipe metal does not come in contact with the concrete masonry.
 - G. Equipment Drains, Drips, Etc.:

- 1. All devices and equipment having drain, drip or blowdown connection shall be piped to nearest floor drain terminating with an elbow over grate, except where otherwise specified.
- 2. Piping shall be run parallel and plumb to walls and shall be braced to walls, floor, other piping or equipment.
- 3. Piping shall be full size of device or equipment connection. Except for relief valve discharges, horizontal drains may be combined into one pipe that is one pipe larger than largest connecting pipe.
- 4. Condensate drains shall be trapped and provided with unions and cleanouts.
- H. Unions shall be provided at all connections to flow control valves, equipment and apparatus.

3.2 PROCEDURES FOR PIPE JOINTS

- A. Welded Joints:
 - 1. All welding of pipe shall conform to the ASME and ANSI Standards B31.1 Power Piping and B31.9 Building Services Piping.
 - 2. Mitering or notching pipe to form elbows and tees will not be permitted. Field and shop bevels shall be in accordance with the recognized standards and shall be done by mechanical means or flame cutting. Where beveling is done by flame cutting, surfaces shall be cleaned of slag, scale and oxidation prior to welding.
 - 3. Before welding, the component parts to be welded shall be aligned so no strain is placed on the weld when finally positioned. Height shall be aligned so that no part of the pipe wall is offset by more than 20 percent of the wall thickness. Flanges and branches shall be set true. This alignment shall be preserved during the welding operations. Connections larger than 6" shall be made with backing rings at welds.
 - 4. Where the temperature of the component parts being welded reaches 32°F or lower, the material shall be heated to approximately 100°F for a distance of 3' on each side of the weld before welding, and the weld shall be finished before the material cools to 32°F. All welds shall be full penetration welds.
 - 5. Defective welds shall be removed and replaced at no additional cost to the Owner. Repairing of defective welds by adding new materials over the defects or by peening will not be permitted.
 - 6. Electrodes shall be stored in a dry, heated area and shall be kept free of moisture or dampness during fabrication operations. Electrodes that have lost part of their flux shall be discarded.
 - 7. Fire protection safeguards shall be employed in connection with welding operations.
 - 8. No welding will be permitted where communication equipment has been installed.
 - 9. Before any welder shall perform any pipe welding, submit a copy of the Welding Operator Qualification Test as required by the referenced standards cited hereinbefore.
- B. Screwed Joints:
 - 1. All threads shall be standard, clean cut and tapered. All burrs shall be reamed from inside of the pipe and pipe shall be turned on end and all loose dirt and scale knocked out.
 - 2. Pipes with threads stripped, chipped or damaged, or split pipe or defective fittings shall not be used.
 - 3. Joint compound shall be applied to the male threads only.

- C. Flanged Joints: Gaskets shall extend to inside the bolt holes, and flanges shall be brought up truly and water and air tight on gaskets by tightening bolts on opposite sides of the pipe.
- D. Copper Tubing Solder Joints:
 - 1. Ends of pipe shall be cut square and cleaned with sand cloth so as to remove all oxides before soldering. Fittings shall be similarly cleaned with sand cloth or wire brush.
 - 2. Flux shall be evenly applied to both pipe end and fittings.
 - 3. Solder shall completely fill all parts of joint. Clean excess flux from pipe after joint completed.

3.3 SLEEVES

- A. Provide all sleeves in floors, beams, walls, roof, etc., as required for installing work of this Division unless otherwise specified hereinafter.
- B. Where exposed in rooms, sleeves in floor slabs, except those on grade, shall project $\frac{1}{4}$ " to $\frac{3}{8}$ " above finished floor.
- C. Sleeves shall be of sufficient size for pipe and full size insulation to pass through.
- D. Sleeves through outside walls above grade shall be caulked watertight between pipe or pipe insulation and sleeve with lead and oakum.
- E. Pipes penetrating walls below grade shall be sealed with a waterproof, modular, mechanical expansion seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the pipe and wall opening. Sizing of links and wall sleeve shall be determined by manufacturer. Thunderline "Link Seal" or Metraflex "Metraseal".
- F. Sleeves through poured concrete shall be secured to the forms before concrete is poured.
- G. Piping passing under or through wall footings, foundations and retaining walls shall be provided with a relieving arc, or an iron pipe sleeve two pipe sizes greater than the pipe passing through.
- H. Sleeves shall be spaced sufficient distance from adjacent walls and other sleeves so that insulation and/or finish plates may be installed without cutting insulation or plates.
- I. Sleeves shall be placed on the piping as it is installed to permit installation of sleeves in walls, partitions, and slabs in one piece.
- J. See Section 23 0500 regarding firestop requirements.

3.4 PRESSURE TESTING

A. See particular piping section for pressure testing requirements.

SECTION 23 2113 HYDRONIC PIPING

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the piping component types and other requirements for the hydronic piping associated with the mechanical systems.
 - B. Hydronic water piping shall connect heat transfer equipment, pumps, components and accessories to form a complete and operable system.

1.2 RELATED SECTIONS

- A. Section 23 0500 Common Work Results for HVAC
- B. Section 23 0523 HVAC Valves and Strainers
- C. Section 23 2000 Pipe, Fittings, and Accessories HVAC
- D. Section 23 2114 Hydronic Specialties
- E. Section 23 2500 Water Treatment Systems
- F. Section 23 8237 Miscellaneous Electric Heaters

1.3 SYSTEM CONDITIONS

A.	The chilled water system shall b	d water system shall be installed for the following conditions:	
	Design Pressure:	125 psig.	
	Working Pressure:	80 psig.	
	Operating Temperature Range:	40°F to 80°F.	

 B. The hot water heating system shall be installed for the following conditions: Design Pressure: 125 psig. Working Pressure: 80 psig. Operating Temperature Range: 70°F to 200°F.

PART 2: PRODUCTS

- 2.1 PIPE
 - A.
 Heating Hot Water
 Black Steel
 Schedule 40

 1.
 Copper piping shall be used in lieu of steel for sizes 2" and smaller.

 B.
 HVAC Condensate
 Copper
 Type M
 - C. Strainer Blowdown, Drains, and Relief Valve Discharge Galvanized Steel Schedule 40
 - 1. Copper piping shall be used in lieu of steel for sizes 2" and smaller.

2.2 FITTINGS AND JOINTS

A. Black steel piping 2¹/₂" and larger shall be butt welded.

- B. Black steel piping smaller than 2½" shall be screwed.
- C. Galvanized steel piping shall be screwed.
- D. Copper piping shall be soldered.

2.3 VALVES

- A. Chilled water valves:
 - 1. Valves 2¹/₂" and larger shall be butterfly type, except where otherwise indicated. Balancing valves, where shown, shall be plug valves.
 - 2. Valves smaller than 2¹/₂" shall be ball type except where otherwise indicated.
- B. Hot water heating valves:
 - 1. Valves shall be ball type except where otherwise indicated.

2.4 PIPE REDUCERS

A. Eccentric type and concentric type.

PART 3: EXECUTION

- 3.1 INSTALLATION
 - A. Install pipe to slope upward in the direction of flow, 1" in 40'.
 - B. Install reducers so as to eliminate unvented high points. Use eccentric reducers on horizontal pipe with flat side on top.
 - C. Install interconnecting piping for apparatus and equipment.
 - D. Exercise care to prevent dirt and foreign matter from entering system. All piping ends shall be capped during construction.

3.2 CLEANING OF PIPING SYSTEM

- A. Refer to Section 23 2500.
- 3.3 PIPE PRESSURE TEST
 - A. Hydrostatically pressure test piping before insulating or concealing. During the test, hammer tap test each weld. Pipe shall hold the test pressure without perceptible leakage or pressure loss. Test piping at not less than 1½ times working pressure, but not greater than design pressure for two hours. Isolate equipment and apparatus that may be damaged during pressure test.

SECTION 23 2114 HYDRONIC SPECIALTIES

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This Section specifies the hydronic system specialty equipment requirements.
- 1.2 RELATED SECTIONS
 - A. Section 23 0010 General Provisions HVAC
 - B. Section 23 0500 Common Work Results for HVAC
 - C. Section 23 0700 Mechanical Systems Insulation
 - D. Section 23 2000 Pipe, Fittings, and Accessories HVAC
 - E. Section 23 2113 Hydronic Piping

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide product data showing equipment dimensions, capacity, weight, pressure rating with associated Code compliance, and pipe connection sizes and locations.
- C. Provide manufacturer's instructions, indicate installation and support requirements.
- D. Provide operation and maintenance data; include start-up instructions, assembly drawings and parts list.

PART 2: PRODUCTS

- 2.1 AUTOMATIC AIR VENTS
 - A. Provide an air vent at each high point of the circulating piping system, except where piping is vented to cooling tower or open expansion tanks. Air vents shall be rated for not less than 125 psig working pressure. Vents shall be American Tube and Controls No. 703, Maid-O-Mist No. 71, or Taco No. 426.

2.2 SUCTION DIFFUSERS

A. Suction diffusers shall be cast iron angle body, NPT threaded in size 2" and smaller and flanged in sizes 2¹/₂" and larger. Casings shall be rated for 175 psi working pressure, 1/4" NPT gauge port, adjustable foot support, 3/4" NPT drain tapping, steel straightening vanes and orifice cylinder, 16 mesh bronze startup strainer, and permanent magnet. Suction diffusers shall be by Armstrong or Bell & Gossett.

PART 3: EXECUTION

- 3.1 INSTALLATION
 - A. Air elimination fittings, makeup connections, and expansion tanks shall be interconnected as indicated on the drawings.

B. Extend automatic air vent discharge pipe to floor drain, air conditioning unit drain pan, out through building wall or as shown on the drawings.

SECTION 23 2124 PUMPS - END SUCTION

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the requirements for base mounted end suction pumps and their motors.
- 1.2 RELATED SECTIONS
 - A. Section 230010 General Provisions HVAC
 - B. Section 230100 Operation and Maintenance of HVAC Systems
 - C. Section 230500 Common Work Results for HVAC
 - D. Section 230700 Mechanical Systems Insulation
 - E. Section 230800 Mechanical Commissioning Requirements

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide product data showing pump curve with system operating point, motor horsepower, electrical requirements and RPM.
- C. Provide shop drawings showing pump dimensions and pipe connection size and accessories.
- D. Provide manufacturer's instructions, indicate installation and support requirements.
- E. Provide operation and maintenance procedures; include start-up instructions, assembly drawings and parts list.

1.4 QUALITY ASSURANCE

- A. All pumps shall be of the same manufacturer.
- B. Select pumps for quiet operation and system conditions. Impeller diameter shall not be larger than 85% of the casing inside diameter measured from the water cut-off point.
- C. Pump efficiency shall not be less than the level scheduled on the plans.
- D. Pump required net positive suction head shall not exceed 12 feet, unless otherwise noted.
- E. Pumps shall be rated for operation at 215°F and 175 psi working pressure, unless otherwise noted.
- F. Pump case and components shall be designed and manufactured as to withstand hydrostatic pressure equal to a minimum of two (2) times the greatest pressure imposed on the system.
- G. Pumps shall have a flange pressure port on the suction and discharge connections.

H. Pumps shall be selected so that motor will not overload to 125% of rated gpm.

PART 2: PRODUCTS

- 2.1 End suction single stage horizontal, base mounted, bronze fitted, except as noted below. Pump shall be Bell and Gossett Series e-1510, Patterson Pro series, Armstrong Series 4030, Aurora 340 Series, or Peerless Type F.
- 2.2 CONSTRUCTION
 - A. Base: Cast iron ASTM A48-56, factory primed and finish painted with drip pan.
 - B. Casing: Cast iron vertically split with vent plug and drain plug.
 - C. Bearings: Steel ball type, external bracket mounted, greasable with fitting, selected for B-10 rating of 100,000 hours.
 - D. Shaft: Carbon steel.
 - E. Seal: Mechanical type, selected for the service encountered. Where external seal flushing line is used, a flush line filter shall be factory installed, selected for the pump head required.
 - F. Shaft Sleeve: Stainless Steel.
 - G. Impeller: Bronze ASTM B144-3B.
 - H. Case Wearing Rings: Bronze ASTM B144-3B.
 - I. Coupling: Flexible type with shaft keys and formed sheet steel guard.
 - J. Motors: NEMA Type B, open drip-proof, premium efficiency type as specified in Section 230500. If inverter duty motors are required, see Section 23 0500 for grounding ring requirements.

PART 3: EXECUTION

- 3.1 Check pump shaft alignment prior to starting pump.
- 3.2 Provide cocks on vents and valves on drains. Pipe drip pans to floor drains.
- 3.3 Provide one (1) set of spare seals for each pump.
- 3.4 Bolt pumps to concrete base and grout in place.
- 3.5 All pumps shall be stored and kept in a dry location. If pumps are subjected to possible freezing ambient conditions, all drain plugs shall be removed to prevent any accumulation of water.
- 3.6 Pumps shall be checked for size, capacity, motor horsepower and voltage.
- 3.7 Pumps shall be lifted by manufacturer's specified rigging points.
- 3.8 Install pumps to as shown on drawings and to allow service clearance required for routine maintenance and motor, casings or impeller removal.
- 3.9 All piping shall be supported individually and separately from the pump so that the piping imposes no thrust or pressure on the pump connections.

3.10 Pumps with 5 horsepower motors and larger must be dynamically balanced, tested, and measured by the Contractor for displacement in the X-Y-Z horizontal, vertical, and axial directions. To be acceptable, work shall comply with ISO standards for velocity. Contractor shall provide a report of vibration readings in the close out documents.

SECTION 23 2125 PUMPS - IN LINE

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the requirements for in line pumps and their motors.
- 1.2 RELATED SECTIONS
 - A. Section 23 0010 General Provisions HVAC
 - B. Section 23 0100 Operation and Maintenance of HVAC Systems
 - C. Section 23 0500 Common Work Results for HVAC
 - D. Section 23 0800 HVAC Commissioning Requirements
 - E. Section 23 0800 Mechanical Commissioning

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide product data showing pump curve with system operating point, motor horsepower, electrical requirements and RPM.
- C. Provide shop drawings showing pump dimensions and pipe connection size and accessories.
- D. Provide manufacturer's instructions, indicate installation and support requirements.
- E. Provide operation and maintenance procedures; include start-up instructions, assembly drawings and parts list.

1.4 QUALITY ASSURANCE

- A. Select pumps for quiet operation and system conditions. Impeller diameter shall not be larger than 85% of the casing inside diameter measured from the water cut-off point.
- B. Pump efficiency shall not be less than the level scheduled on the plans.
- C. Pump required net positive suction head shall not exceed 12 feet, unless otherwise noted.
- D. Pumps shall be rated for operation at 215°F and 175 psi working pressure, unless otherwise noted.
- E. Pumps shall be selected so that motor will not overload to 125% of rated gpm.

PART 2: PRODUCTS

- 2.1 IN LINE BOILER CIRCULATION PUMPS
 - A. The pumps shall be a wet rotor inline pump, in lead free bronze body construction specifically designed for quiet operation. The pumps shall be suitable for operation at 175 pisg working pressure and 230°F operating temperature.
 - B. The pump internals shall be capable of being serviced without disturbing piping connections.
 - C. Pump shall be equipped with a water-tight seal to prevent leakage.
 - D. Pump volute shall be lead free bronze with 2 or 4 bolt flanged connections.
 - E. Motor shall be a synchronous, permanent-magnet (PM) motor and tested with the pump as one unit. Conventional induction motors will not be acceptable.
 - F. Each motor shall have an Integrated Variable Frequency Drive tested as one unit by the manufacturer.
 - G. Integrated motor protection shall be verified by UL to protect the pump against over/under voltage, over temperature of motor and/or electronics, over current locked rotor and dry run (no load condition).
 - H. Pump shall have BACnet connections built into the VFD as a standard option.
 - I. Analog inputs, such as 0-10V and 4-20mA, are standard inputs built into the VFD.
 - J. Pumps shall be UL 778 listed and bear the UL Listed Mark for USA and Canada with on-board thermal overload protection.
 - K. Each pump shall be factory performance tested before shipment.
 - L. Operating Modes:
 - 1. Proportional Pressure The differential pressure will continuously increase or decrease along a linear curve based on the flow demand.
 - 2. Constant Pressure The pump maintains a constant differential pressure set by the user at any flow demand until the maximum speed is reached.
 - 3. Constant Speed The pump maintains a constant speed at any flow rate
 - 4. Night Set Back The pump will recognize a 10°C water temperature reduction and will switch to nighttime operation.
 - 5. T-Constant This control will use a PI algorithm to vary the speed of the pump in order to maintain a constant temperature of the fluid media.
 - 6. Delta-T Constant This control mode will use a PI algorithm to vary the speed of the pump in order to maintain a constant differential temperature between the built-in temperature sensor and external temperature sensor.
 - Delta-P-T This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the fluid temperature.
 - Delta-P-Delta-T This control mode is paired with proportional or constant pressure mode. The nominal differential pressure setpoint will vary according to the differential temperature between the built-in temperature sensor and external temperature sensor.
 - M. Pump shall be Bell & Gossett ecocirc XL or approved equal.

2.2 IN LINE PUMPS OVER 3 HP

- A. In line, single stage, vertical, close coupled, bronze fitted, with mechanical seal. Pump shall be Bell and Gosset Series 80, Armstrong Series 4380, Aurora 380 Series, or Patterson VIL series.
- B. Construction:
 - 1. Casing: Cast iron with cast iron cylinder bracket connecting pump to motor.
 - 2. Shaft: Steel.
 - 3. Seal: Mechanical type, serviceable without breaking pipe connections, selected for the service encountered.
 - 4. Impeller: Bronze ASTM B119.
 - 5. Case Wearing Rings: Renewable bronze ASTM 62-4A.
 - 6. Motors: NEMA Type B, open drip-proof, premium efficiency type where scheduled.
- C. Bearing Protection Ring: All motors being controlled by the use of a Variable Frequency Drive (VFD) shall be provided with a factory installed grounding ring to prevent fluting damage. Ring shall be continuous. Bearing Protection Ring shall be AEGIS model SGR.

PART 3: EXECUTION

- 3.1 All pumps shall be stored and kept in a dry location. If pumps are subjected to possible freezing ambient conditions, all drain plugs shall be removed to prevent any accumulation of water.
- 3.2 Pumps shall be checked for size, capacity, motor horsepower and voltage.
- 3.3 Pumps shall be lifted by manufacturer's specified rigging points.
- 3.4 Provide cocks on vents and valves on drains. Pipe drip pans to floor drains.
- 3.5 Provide one (1) set of spare seals for each pump.
- 3.6 Install pumps to as shown on drawings and to allow service clearance required for routine maintenance and motor, casings or impeller removal.
- 3.7 All piping shall be supported individually and separately from the pump so that the piping imposes no thrust or pressure on the pump connections.
- 3.8 Pumps with 5 horsepower motors and larger must be dynamically balanced, tested, and measured by the Contractor for displacement in the X-Y-Z horizontal, vertical, and axial directions. To be acceptable, work shall comply with ISO standards for velocity. Contractor shall provide a report of vibration readings in the close out documents.

SECTION 23 3100 DUCTWORK

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the sheetmetal requirements for Division 23 ductwork.
- 1.2 RELATED SECTIONS
 - A. Section 23 0500 Common Work Results for HVAC
 - B. Section 23 0700 Mechanical Systems Insulation
 - C. Section 23 0593 Testing, Balancing and Adjusting
 - D. Section 23 0933 Electronic Automatic Controls
 - E. Section 23 3713 Grilles, Registers, and Diffusers

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide data on damper performance including, but not limited to, total static pressure drop verses airflow shown for all multi-blade dampers, size and quantity of dampers required.
- C. Provide shop drawing showing multi-blade damper dimensions, construction, duct connection sizes and electrical requirements.
- D. Provide manufacturer's instructions, indicate installation and support requirements.
- E. Provide data on each liner type including, but not limited to, application, material, finish, thickness, density, operating temperature range, and mean thermal conductivity and related temperature.
- F. Provide manufacturer's instructions indicating installation and support requirements for duct liner.

1.4 STANDARDS

- A. ASHRAE 52.2-1999 Ventilation for Acceptable Indoor Air Quality.
- B. Refer to the SMACNA "HVAC Duct Construction Standards, Metal and Flexible", Third Edition, 2005, latest printing published by SMACNA.
- C. Refer to the SMACNA "Duct Cleanliness for New Construction Guidelines", latest printing.
- D. Unless noted otherwise herein, all ductwork shall be constructed, sealed, and supported in strict compliance with the SMACNA standards referenced above.
- E. UL 181A Closure Systems for Use with Rigid Air Ducts.
- F. UL 181B Closure Systems for Use with Flexible Air Ducts and Air Connectors.

1.5 PRESSURE AND VELOCITY RATINGS

A. Supply ductwork, return ductwork, and exhaust ductwork, unless otherwise noted, shall be constructed and reinforced for 2000 FPM velocity and 2" static positive or negative. This construction shall be referred to as "low pressure".

1.6 DUCT DIMENSIONS

A. Dimensions shown on the drawings are metal-to-metal size, unless noted otherwise.

PART 2: PRODUCTS

2.1 METAL MATERIALS

- A. Sheetmetal shall be hot dipped galvanized steel of lock forming quality with minimum zinc coating of 1.25 ounces per square foot each side per ASTM A525. Exposed duct to be painted shall be "paint-grip" type or treated to accept paint.
- B. Formed reinforcing drives, slips, pocket locks, and standing seams shall be constructed from sheet metal stock of the same material as the associated ductwork. Intermediate reinforcing angles may be uncoated steel painted with two coats of primer.
- C. Round and flat oval ductwork shall be factory fabricated low-pressure spiral lock seam type constructed in accordance with the above-referenced SMACNA standards. <u>Round snap-lock type ductwork shall not be installed on project</u>. All fittings shall be factory fabricated by same manufacturer as ductwork. Round duct below grade shall be minimum 20 gauge. Manufacturers shall be Semco, Monroe Metal, United Sheet Metal, Lindab, or approved equivalent.

2.2 PLENUMS AND CASINGS

- A. Field-fabricated plenums and casings shall be constructed per referenced SMACNA standards, except minimum steel gauge shall be 18 and minimum angle size 1" x 1" x 1/8". Angles shall be galvanized. Access doors shall be hinged, gasketed, and latched. Minimum size shall be 20" width by 48" high unless casing is 60" or less high. Door height shall be adjusted to 12" less than casing height for casings less than 60" high. All plenums shall be lined with 1" (2") thick rigid Type II duct liner.
- B. Cover entire surface of plenum over liner with 22 gauge perforated galvanized sheets with 1/8" diameter openings on 5/8" centers, attached with stick clips spaced at 18" on center each way, spot welded with 1" galvanized disc washers.

2.3 ACCESSORIES

A. Access doors shall be galvanized steel hinged and latched insulated type, minimum 8" x 8" size, manufactured per referenced SMACNA standards. Where access to equipment requires a larger door, size shall be increased to allow full accessibility. Hinges shall be furnished with brass pins. Where hinges do not allow for access, latches shall be provided on all sides. Manufacturers shall be Air Balance, Krueger, Nailor, Ruskin, or Ventlok.

B. Low VOC water-based duct sealing compounds shall be manufactured to comply with NFPA 90A, UL listed and complying with ASTM E84. The sealants must be rated for high pressure applications, both indoor and outdoor, and also comply with the current VOC limits of the Bay Area Air Quality Management District Regulation 8, Rule 51, with a maximum VOC emission of 250 grams per liter. Sealants shall be by Ductmate, Foster, or Hardcast. Pressure sensitive tape is not acceptable.

2.4 BACKDRAFT DAMPERS

A. Backdraft dampers shall be multi-blade parallel action type. Frames shall be formed 20-gauge galvanized steel. Maximum individual damper width shall not exceed 42". Blades shall be 5" (maximum) wide, constructed of 28 U.S. Gauge (minimum thickness) formed galvanized steel attached to stainless steel pins and fitted with mechanically bonded vinyl blade seals. Ruskin S3G or equal by Arrow United, Cesco, Nailor Industries, Greenheck, or National Controlled Air.

2.5 CONTROL DAMPERS

A. See Section 23 0923 Building Automation and Temperature Control System for control dampers.

PART 3: EXECUTION

- 3.1 GENERAL DUCTWORK INSTALLATION
 - A. All ductwork shall be fabricated, stored, and installed per the SMACNA "Duct Cleanliness Guidelines for Intermediate Level Cleanliness". This guide includes the requirement for ducts to be stored in a clean, dry area, the installation area shall be protected from the elements, and temporary closure of open ends on completed ducts, and other measures intended to minimize contamination of the circulating air.
 - B. All (existing or new) ductwork that is open-ended (temporarily or permanently) shall be covered, sealed and protected to eliminate the entry of foreign debris into the ductwork system. All existing return air ductwork that is to be open-ended during construction shall be covered with MERV 8 filter media.
 - C. Provide offsets, elbows, and transitions to coordinate with other work. Changes in shape or dimension shall be made with a maximum slope as noted in SMACNA HVAC Duct Construction Standards.
 - D. Ducts over 12" in either dimension, except those to be externally insulated with rigid board or internally insulated, shall have all sides cross.
 - E. Leave system clean from dust, trash, and foreign matter.
 - F. Installation shall be airtight and free from rattles, vibration, and movement.
 - G. Provide access doors for access to fire dampers, smoke dampers, fire/smoke dampers, controls, coils, duct smoke detectors, humidifiers, and where required for cleaning, oiling, inspection, and maintenance.
 - H. Paint interior ductwork visible behind grilles or register flat black. Do not paint fire damper, smoke damper or fire/smoke damper.
 - I. Coordinate locations that ductwork is required to be painted with architect and engineer. In general, all exposed ductwork in occupied areas shall be paint grip type and shall be painted color as chosen by owner/architect.

3.2 DUCTWORK SUPPORT

- A. Ductwork shall be supported per SMACNA standards except hanger spacing shall not exceed 8' for rectangular duct and 10' for round rigid ductwork.
- B. Ductwork penetrating floors in equipment rooms shall be provided with a 4" high concrete curb around the duct.
- C. Support vertical risers at each floor.

3.3 LOW PRESSURE DUCTWORK

- A. Squared and radiused elbows shall be constructed as per Figure 4-2 of referenced SMACNA standards, except no mitered elbows or square elbows without vanes are allowed. Turning vanes shall be constructed as per Figures 4-3 and 4-4.
- B. Divided flow branches shall be constructed as per Figure 4-5 of referenced SMACNA standards, always with splitter damper.
- C. TDC and TDF duct joint systems may be used as outlined in SMACNA standards, provided corner pieces are used and bolted at all locations.

3.4 DUCT SEALING

- A. Seal Levels:
 - 1. Seal Class A Seal all transverse joints, longitudinal seams, and all duct wall penetrations.
 - 2. Seal Class B Seal all transverse joints and longitudinal seams.
 - 3. Seal Class C Seal all transverse joints.
- B. Seal Procedures:
 - 1. All longitudinal and transverse joints, seams and connections in and between metallic and non-metallic ducts shall be constructed as specified in SMACNA HVAC Duct Construction Standards.
 - Seal joints per SMACNA procedures with duct sealer as duct is erected. Sealing ductwork after erection is complete will not be accepted. Cover all joints to be sealed with sealer and assemble in normal fashion. Duct Seal Levels are as follows:
 - a. For Seal Level A and B: Pressure sensitive tape shall not be used as the primary sealant, unless it has been certified to comply with UL 181A or UL 181B by and independent testing laboratory and the tape is used in accordance with that certification.
 - 3. Where ductwork is bolted together, provide 1/8" thick gaskets at each bolted joint per SMACNA standards.
 - 4. Spiral lock seams in a round or flat oval duct need not be sealed. All other connections are considered transverse joints, including but not limited to spinins, taps, and other branch connections, access door frames and jambs, duct connections to equipment, etc.
 - 5. Closure systems used to seal factory-made rigid air ducts or air connectors shall comply with UL 181A and shall be marked "181A-P" for pressure-sensitive tape, "181A-M" for mastic, or "181A-H" for heat-sensitive tape.

- Closure systems used to seal flexible air ducts and flexible air connectors shall comply with UL 181B and shall be marked "181B-FX" for pressure-sensitive tape or "181B-M" for mastic.
- 7. Duct connections to flanges of air distribution system equipment shall be sealed and mechanically fastened. Mechanical fasteners for use with flexible nonmetallic air ducts shall comply UL 181B and shall be marked "181B-C".
- 8. Openings for rotating shafts shall be sealed with bushings or other devices that seal off air leakage.
- 9. Unlisted duct tape is not permitted as a sealant on any duct.
- C. All low-pressure ductwork shall be sealed as follows:
 - 1. Exterior Seal Class A, except for exhaust ducts, which shall be Seal Class C.
 - 2. Unconditioned Interior Space Seal Class B except for exhaust ducts, which shall be Seal Class C.
 - 3. Plenums or Conditioned Space Seal Class C, except for exhaust ducts, which shall be Seal Class B.

3.5 FIELD-FABRICATED PLENUMS

- A. Reinforcing frame shall consist of base angles set on gasket and bolted to foundations. Horizontal and vertical frame angles shall be spaced as per SMACNA requirements. Angles shall be bolted or welded together. Access door openings shall be framed on four sides. Plenum casings shall be bolted, riveted or spot welded to inside surface of angle frame. Seal all joints with gaskets.
- B. Plenum doors shall be installed to close with plenum pressure. Install doors on sills, minimum 6" for 60" high casing, otherwise 8".
- C. Install finish over liner on all surfaces of plenum.
- 3.6 EXHAUST FLUE AND COMBUSTION AIR DUCTS shall be installed per the manufacturer's instructions.
- 3.7 DUCT LINER AND FINISH
 - A. All portions of ductwork or plenums designated to be lined shall be completely covered with duct liner. Fasten duct liner to sheetmetal with coated surface facing the airside and secured with ASTM C916 compliant adhesive with 100% coverage and mechanical fasteners per the requirements of the above-referenced SMACNA standards. Mechanical fasteners shall not compress the insulation more than 1/8" and shall be spaced per the SMACNA Standards.
 - B. Metal nosing shall be provided at transverse edge of liner facing the fan discharge when air velocities exceed 2000 F.P.M. or at any point where lined duct is preceded by unlined duct. Locate mechanical fasteners within 3" of leading edge of liner across entire face. Butt liner joints together to form a continuous liner surface.
 - C. Any damage to the airside surface must be repaired by coating with duct liner adhesive.

SECTION 23 3713 GRILLES, REGISTERS, AND DIFFUSERS

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies grilles, registers, and diffusers furnished and installed under Division 23.
- 1.2 RELATED SECTION
 - A. Section 23 3100 Ductwork

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide data on air distribution performance including, but not limited to, total static pressure drop and sound generation (NC) verses airflow shown for each supply and return grille, size, and quantity of grilles required.
- C. Provide shop drawing showing catalog illustrations, dimensions, duct connection sizes, and accessories.
- D. Provide manufacturer's instructions; indicate installation and support requirements.
- E. Clearly indicate on all cut sheets the submittal grille, register and diffuser Type (i.e. S-1, R-2, E-3) as shown on the drawings.

1.4 QUALITY ASSURANCE

- A. Performance of grilles, registers, and diffusers shall be tested in accordance with ANSI/ASHRAE Standard 70, latest edition.
- B. All grilles, registers, and diffusers shall be selected and furnished by one manufacturer.

PART 2: PRODUCTS

- 2.1 GENERAL
 - A. Grilles, registers, and diffusers have been selected from one manufacturer's catalog. Alternate manufacturers shall be Titus, Metalaire, Price, Krueger, or Nailor Industries.
 - B. All grilles and registers with borders shall be furnished with gasketed seals around the perimeter. All grilles, registers, and diffusers shall be aluminum or steel, as scheduled.
 - C. Register dampers shall be gang operated opposed blade type, operable through the face of the diffuser.
 - D. Provide factory installed 2" thermally insulated backpans on all 12x12 and 24x24 diffusers.

PART 3: EXECUTION

- 3.1 TEMPORARY DUST PROTECTION
 - A. In order to prevent the circulation of construction dust in the building, protect all air outlets on the new and existing zones being modified with one layer of Dyn-O-Wrap or similar self-adhesive film.
 - B. Apply dust protection to each register, grille or diffuser before any duct construction work is started. Maintain dust protection as directed by Owner.

3.2 INSTALLATION

- A. Attach ceiling diffusers to flex duct connection in a secure fashion with tightly secured UL listed draw bands.
- B. Attach ceiling diffusers to flex duct connection in a secure fashion with Flexmaster "Quick Release – LS Series" stainless steel clamps.
- C. Install offset return grilles so that blade offset is angled down towards the floor.
- D. Coordinate exact location of ceiling diffusers and grilles with reflected ceiling plan.

SECTION 23 5100 BREECHINGS, CHIMNEYS & STACKS

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. Listed Special Gas Vents.
 - B. Related Sections include the following:
 - 1. Section 235113 "Draft Control Devices" for draft control and dampers.
- 1.3 ACTION SUBMITTALS
 - A. Product Data: For the following:
 - 1. Special gas vents.
 - 2. Draft Control Devices
 - B. Shop Drawings: For vents, breechings, chimneys, and stacks. Include plans, elevations, sections, details, and attachments to other work.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain listed system components through one source from a single manufacturer.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.
- C. Certified Sizing Calculations: Manufacturer shall provide certified, comprehensive venting system sizing calculation analysis for all conditions including firing rates, ambient temperatures, elevation and number of appliances

1.5 WARRANTY/ GUARANTEE

- A. Special Gas Vent lifetime product warranty against defects in workmanship for the entire duration the product is incorporated and used in its original installation when product is properly installed per the manufacturer's installation instructions.
- B. Special Gas Vent product leak free guarantee for three (3) years after purchase per the manufactures guidelines for compliance.

PART 2: PRODUCTS

- 2.1 LISTED SPECIAL GAS VENTS
 - A. Basis-of-Design Product: eVent[™] with DualSeal[™] product by Schebler Chimney Systems.
 - B. Description: The factory built double wall modular chimney shall be laboratory tested and listed with Underwriters Laboratories Standard UL 1738 for use with category II, III, & IV appliances with a maximum flue gas temperature of 550°F and ULC-S636-95 for gas vent – BH, Class I/Class II 245°C. Product must have UL pressure rating of 40"w.c. Product to have leak free guarantee for three (3) years and lifetime product warranty backed by the manufacture.
 - C. Construction: Between the inner and outer shells there shall be a minimum of a 1" air gap. Stainless steel centering clips shall be welded to the outer shell to maintain the 1" spacing and ensure concentricity of the shells. Vent sections shall be sealed by use of a ½" flange to flange and factory applied gasket to gasket design. Flanges to be coupled using RapidLock[™] bands. No sealant is allowed for joints or variable sections allowing immediate start-up of appliance.
 - D. Inner Shell: Inner liner material shall be 24 gauge (.024") AL29-4C stainless steel. All inner shell seams shall be full penetration welded the entire length of the pipe section. Riveted, tack or spot welded seams are not permitted on any part or fitting.
 - E. Outer Jacket: Outer shell material shall be 22 gauge (.030") 430 stainless steel. All outer shell seams shall be full penetration welded the entire length of the pipe section. Riveted, tack or spot welded seams are not permitted.
- 2.2 SEQUENCE DRAFT CONTROL
 - A. Manufacturers: Sequence Draft Control[™] by Schebler Chimney Systems.
 - B. Description: Sequence Draft Control[™] engineered venting solution that maintains proper outlet pressure for each appliance that is tied into a common vent system. Each appliance will have a modulating damper with a pressure sensor line which will monitor and control pressure or draft to the appliance manufactures requirements. This solution must be supplied by same supplier as special gas vent material to ensure one source responsibility.
 - C. Construction:
 - Modulating dampers (1) per each boiler or water heater installed in the vertical riser to be UL-1738 compliant produced from type AL29-4C stainless steel and/or 316L stainless steel suited for vent category II or category IV condensing appliance venting. Each damper complete with optional tapping's for combustion analysis and manometer insertion
 - a. Damper actuators (1) per each boiler, high performance spring return direct coupled up to 175 in-lb of torque with adjustable auxiliary switch.
 - b. Control Differential pressure control response time 250ms
 - c. Wall mounted UL listed, NEMA Rating 12 control panel enclosure with hinge, The wall mounted control panel with digihelic pressure controllers, per each appliance being controlled with programming capabilities to match appliance outlet pressure requirements.

2.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- E. Lap joints in direction of flow.
- F. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.
- G. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.
- H. Erect stacks plumb to finished tolerance of no more than 1 inch (25 mm) out of plumb from top to bottom.

SECTION 23 5235

CONDENSING STAINLESS STEEL HEATING HOT WATER BOILER

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the requirements for packaged, factory-fabricated and assembled, gas-fired, fire-tube condensing boilers, trim, and accessories for heating hot water.
- 1.2 RELATED SECTIONS
 - A. Section 23 0010 General Provisions HVAC
 - B. Section 23 0100 Operation and Maintenance of HVAC Systems
 - C. Section 23 0500 Common Work Results for HVAC
 - D. Section 23 0800 HVAC Commissioning Requirements
 - E. Section 23 2113 Hydronic Piping
 - F. Section 23 2500 Water Treatment System

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide shop drawing showing boiler dimensions, capacities, weight, pressure rating, electrical requirements and pipe connection sizes and locations.
- C. Provide shop drawings for control panel showing the proposed wiring diagram with accompanying complete typewritten sequence of operations. A symbols list defining all abbreviated components shall be included. A cut sheet on each component used in the system shall be included. The diagram shall delineate between power and control wiring and shall indicate all contactors, relays, and other components of the system. Normally open positions for the relays shall be indicated.
- D. Provide shop drawings for boiler flue routing, including required venting category, flue material, and flue size.
- E. Provide manufacturer's instructions, indicate installation and support requirements.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers Minimum Efficiency Requirements."

- D. AHRI Compliance: Boilers shall be AHRI listed and must meet the minimum efficiency specified under AHRI BTS-2000 as defined by Department of Energy in 10 CFR Part 431.
- E. ANSI Compliance: Boilers shall be compliant with ANSI Z21.13 test standards for US and Canada. Boilers shall be tested in an ISO 17025 recognized laboratory. Boilers tested to UL 795 shall not be permitted.
 - ANSI Z21.13 pertains to gas-fired low-pressure steam and hot water boilers. UL 1. 795 pertains to commercial-industrial gas heating equipment.
- F. CSA Compliant: Boilers shall be compliant with CSA certification.

WARRANTY 1.5

- Standard Warranty: Boilers shall include manufacturer's standard form in which Α. manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - Warranty Period for Fire-Tube Condensing Boilers: 1.
 - Heat Exchanger, Pressure Vessel and Condensation Collection Basin shall a. carry a 10 year limited warranty against defects in materials or workmanship and failure due to thermal shock.
 - All other components shall carry a one year warranty from date of boiler b. start up.

PART 2: PRODUCTS

- 2.1 CONDENSING STAINLESS STEEL HEATING HOT WATER BOILER
 - Α. Boiler shall be natural gas fired, sealed combustion, condensing type with powered venting. The boiler shall operate up to 96.2% thermal efficiency at full fire as registered with AHRI. The boiler shall be certified for indoor installation.
 - B. Construction:
 - Boiler shall be natural gas fired, fully condensing, and fire tube design. The boiler 1. shall be factory-fabricated, factory-assembled, and factory-tested, fire-tube condensing boiler 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. The heater exchanger shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed. The heat exchanger shall be constructed of a fully welded 316L stainless steel and of fire tube design. Fire tube shall be of the Wave Fire Tube design and capable of transferring 16,000 to 20,000 Btu's per tube. The heat exchanger shall be designed for a singlepass water flow to limit the water side pressure drop. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger design. Cast iron, aluminum, or condensing copper tube boilers will not be accepted.
 - Condensate collection basin shall be fully welded 316L stainless steel. 3.
 - Intake Filter and Dirty Filter Switch: Boiler shall include an intake air filter with a 4. factory installed air pressure switch. The pressure switch will alert the end user on the screen of the boiler that the intake filter is dirty and needs to be changed.

- 5. Pressure Vessel: The pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The pressure vessel shall be designed for a single-pass water flow to limit the water side pressure drop. Pressure drop shall be no greater than 6.5 psi at 180 gpm. The pressure vessel shall contain a volume of water no less than 110 gallons.
- 6. Natural gas, forced draft single burner premix design with an upper and lower chamber supplied by individual combustion systems. The burner shall be high temperature stainless steel with a woven Fecralloy outer covering to provide modulating firing rates. The burner shall be capable of the stated gas train turndown without loss of combustion efficiency. The burner shall have an independent laboratory rating for Oxides of Nitrogen (NOx) to meet requirements of South Coast Air Quality Management District (SCAQMD) as compliant with Rule 1146.2, San Diego Air Control Pollution District as compliant with Regulation 69.2.1, Bay Area Quality Management District as compliant with Regulation 9 Rule 7 and Texas Commission on Environmental Quality as being compliant with Section 117.465.
- 7. Blower: Boiler shall be equipped with a pulse width modulating blower system to precisely control the fuel/air mixture to provide modulating boiler firing rates for maximum efficiency. The burner firing sequence of operation shall include pre-purge, firing, modulation, and post-purge operation.
 - a. Motors: Comply with requirements specified in Section 23 0500.
- 8. Gas Train: The boiler shall be supplied with two gas valves designed with negative pressure regulation and shall be capable of minimum 25:1 turndown.
- 9. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- 10. Casing
 - a. Jacket: Heavy gauge primed and painted steel jacket with snap-in closures.
 - b. Control Compartment Enclosures: NEMA 250, Type 1A.
 - c. Insulation: Minimum ½ inch thick, mineral fiber insulation surrounding the heat exchanger.
 - d. Combustion-Air Connections: Inlet and vent duct collars.
- 11. Characteristics and Capacities
 - a. Heating Medium: Hot water.
 - b. Design Water Pressure Rating: 160 psi working pressure.
 - c. Safety Relief Valve Setting: 150 psig
 - d. Minimum Water Flow Rate: 25 GPM
- C. Trim:
 - 1. Safety Relief Valve:
 - a. Size and Capacity: 150 lb.
 - b. Description: Fully enclosed steel spring with adjustable pressure range and positive shutoff; factory set and sealed.
 - 2. Pressure Gage: Minimum 3-1/2 inch diameter. Gage shall have normal operating pressure about 50 percent of full range.
 - 3. Drain Valves: Minimum NPS 3/4 or nozzle size with hose-end connection.
 - 4. Condensate Neutralization Kit: Factory supplied condensate trap with condensate trip sensor, high capacity condensate receiver prefilled with appropriate medium.

D. Controls:

- 1. Boiler controls shall feature a standard, factory installed 8" LCD screen display with the following standard features:
 - a. Variable Speed Boiler Pump Control: Boiler may be programmed to send a 0-10V DC output signal to an ECM or VFD boiler pump to maintain a designed temperature rise across the heat exchanger. The boiler shall be able to operate in this mode with a minimum temperature rise of 20 degrees F and a maximum temperature rise of 60 degrees F. Project specific temperature rise shall be as scheduled.
 - b. Password Security: Boiler shall have a different password security code for the User and the Installer to access adjustable parameters.
 - c. Outdoor air reset: Boiler shall calculate the set point using a field installed, factory supplied outdoor sensor and an adjustable reset curve.
 - d. Pump exercise: Boiler shall energize any pump it controls for an adjustable time if the associated pump has been off for a time period of 24 hours.
 - e. Ramp delay: Boiler may be programmed to limit the firing rate based on six limits steps and six time intervals.
 - f. Boost function: Boiler may be programmed to automatically increase the set point a fixed number of degrees (adjustable by installer) if the setpoint has been continuously active for a set period of time (time adjustable by installer). This process will continue until the space heating demand ends.
 - g. Domestic hot water priority: Boiler shall make the domestic hot water call for heat a priority over any space heating call and adjust the boiler setpoint to the domestic hot water boiler setpoint.
 - h. Domestic hot water modulation limiting: Boiler may be programmed to limit the maximum domestic hot water firing rate to match the input rating of the indirect tank coil.
 - i. Domestic hot water night setback: Boiler may be programmed to reduce the domestic hot water tank set point during a certain time of the day.
 - j. PC port connection: Boiler shall have a PC port allowing the connection of PC boiler software.
 - k. Time clock: Boiler shall have an internal time clock with the ability to time and date stamp lock-out codes and maintain records of runtime.
 - I. Service reminder: Boiler shall have the ability to display a yellow colored service notification screen based upon months of installation, hours of operation, and number of boiler cycles. All notifications are adjustable by the installer.
 - m. Three pump control: Boiler shall have the ability to control the boiler pump, system pump and the domestic hot water pump.
 - n. Anti-cycling control: Boiler shall have the ability to set a time delay after a heating demand is satisfied allowing the boiler to block a new call for heat. The boiler will display an anti-cycling blocking on the screen until the time has elapsed or the water temperature drops below the anti-cycling differential parameter. The anti-cycling control parameter is adjustable by the installer.
 - o. Night setback: Boiler may be programmed to reduce the space heating temperature set point during a certain time of the day.
 - p. Freeze protection: Boiler shall turn on the boiler and system pumps when the boiler water temperature falls below 45 degrees. When the boiler water temperature falls below 37 degrees the boiler will automatically turn on. Boiler and pumps will turn off when the boiler water temperature rises above 43 degrees.
- q. Isolation valve control: Boiler shall have the ability to control a 2-way motorized control valve. Boiler shall also be able to force a fixed number of valves to always be energized regardless of the number of boilers that are firing.
- r. BMS integration with 0-10V DC input: The Control shall allow an option to Enable and control set point temperature or control firing rate by sending the boiler a 0-10V input signal.
- s. Data logging: Boiler shall have non-volatile data logging memory including last 10 lockouts, hours running and ignition attempts and should be able to view on boiler screen.
- 2. The boiler shall have a built in Cascade controller to sequence and rotate lead boiler to ensure equal runtime while maintaining modulation of up to 8 boilers of different btu inputs without utilization of an external controller. The factory installed, internal cascade controller shall include:
 - a. Lead lag:
 - b. Efficiency optimization: The Control module shall allow multiple boilers to fire at minimum firing rate in lieu of Lead/Lag.
 - c. Front end loading:
 - d. Rotation of lead boiler: The Control module shall change the lead boiler every hour for the first 24 hours after initializing the Cascade. Following that, the leader will be changed once every 24 hours.
- 3. Boiler operating controls shall include the following devices and features:
 - a. Set-Point Adjust: Set points shall be adjustable.
 - b. Operating Pressure Control: Factory wired and mounted to cycle burner.
 - c. Sequence of Operation: Factory installed controller to modulate burner firing rate to maintain system water temperature in response to call for heat.
 - d. Sequence of Operation: Electric, factory-fabricated and factory-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 10 deg F outside-air temperature, set supply-water temperature at 180 deg F; at 60 deg F outside-air temperature, set supply-water temperature at 145 deg F.
- 4. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - a. High Temperature Limit: Automatic and manual reset stops burner if operating conditions rise above maximum boiler design temperature. Limit switch to be manually reset on the control interface.
 - b. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be manually reset on the control interface.
 - c. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - d. High and Low Gas Pressure Switches: Pressure switches shall prevent burner operation on low or high gas pressure. Pressure switches to be manually reset on the control interface.
 - e. Blocked Drain Switch: Blocked drain switch shall prevent burner operation when tripped. Switch to be manually reset on the control interface.
 - f. Low air pressure switch: Pressure switches shall prevent burner operation on low air pressure. Switch to be manually reset on the control interface.
 - g. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for any lockout conditions.

- Building Automation System Interface: Factory installed BACnet MSTP gateway 5. interface to enable building automation system to monitor, control, and display boiler status and alarms.
- E. **Electrical Power:**
 - 1. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26 Sections.
 - 2. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - Electrical Characteristics shall be as scheduled on the drawings. 3.
- F. Ventina:
 - Exhaust flue shall be Category IV as specified in Section 23 3100. Boiler's 1. exhaust vent length must be able to extend to 100 equivalent feet.
 - Boiler venting and intake piping configuration shall be as shown on the drawings. 2.
 - 3. Boiler shall come standard with a flue sensor to monitor and display flue gas temperature on factory provided LCD display.
- Source Quality Control: G.
 - Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, 1. carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
 - 2. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
- Boiler shall be Lochinvar Crest or equal by Camus or Laars. Η.

PART 3: EXECUTION

- 3.1 **EXAMINATION**
 - Α. Before boiler installation, examine roughing-in for concrete equipment bases, anchorbolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - Β. Examine mechanical spaces for suitable conditions where boilers will be installed.
 - C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 **BOILER INSTALLATION**

- Α. Install equipment on 4" concrete housekeeping pad.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.
- CONNECTIONS 3.3
 - Install boilers level on concrete bases. Α.

- B. Install piping adjacent to boiler to allow service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of equipment connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return boiler tappings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting:
 - 1. Install flue venting kit and combustion-air intake.
 - 2. Connect full size to boiler connections. Comply with requirements in Section 23 3100.
- H. Ground equipment according to Division 26 requirements.
- I. Connect wiring according to Division 26 requirements.

3.4 BOILER START-UP

- A. Provide the services of a factory trained technician to place the boiler in operation and instruct the Owner's representative in operation and maintenance of the system. An operational test of the boiler performance shall be made at this time and the report submitted in triplicate to Architect.
 - 1. Tests and Inspections:
 - a. Perform installation and startup checks according to manufacturer's written instructions. Complete startup form included with Boiler and return to Manufacturer as described in the instructions.
 - b. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - c. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - e. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - f. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.5 GAS PIPING VENTS

- A. Extend all gas regulator and switch vents to a point outside the building at least 10 feet above grade and 5 feet from any opening into the building. Terminate vent lines in a flash arrester.
- 3.6 BOILER COMBUSTION VENTS

Confirm boiler vent category and material system required for flue venting. Provide Α. condensing trap loop for all condensing installations per boiler manufacturer's instructions.

3.7 **BOILER INSPECTION**

- Α. Boiler shall be checked and piping inspected by the State Boiler Inspector prior to startup. Contact the state Department of Labor office at 404-679-0687 regarding this inspection and pay all fees associated with the inspection. Contractor shall obtain boiler permit prior to final inspection.
- Submit report from inspector indicating that boiler installation has been inspected and Β. accepted.

RELIEF VALVE 3.8

Α. Extend relief valve discharge full size to floor drain.

SECTION 23 5721 PLATE HEAT EXCHANGER

PART 1: GENERAL

- 1.1 DESCRIPTION
 - A. This section specifies the requirements for plate heat exchangers.
- 1.2 RELATED SECTIONS
 - A. Section 23 0010 General Provisions HVAC
 - B. Section 23 0100 Operation and Maintenance of HVAC Systems
 - C. Section 23 0500 Common Work Results for HVAC
 - D. Section 23 0700 Mechanical Systems Insulation
 - E. Section 23 2113 Hydronic Piping System

1.3 SUBMITTALS

- A. See General Conditions for submittal procedure.
- B. Provide data on unit performance including, but not limited to, entering water temperatures, leaving water temperatures, capacity, and chilled water and condenser water flow and associated pressure drop.
- C. Provide submittal showing heat exchanger dimensions, weight, materials of construction, pressure rating, and service access requirements. Submittal shall indicate connection sizes and locations for inlet and outlet of hot and cold fluids. Heat exchanger shall be shipped with these same connections physically identified.
- D. Provide manufacturer's instructions; indicate installation and support requirements.
- E. Provide operation and maintenance procedures; include start-up instructions, assembly drawings, and parts list.

1.4 QUALITY ASSURANCE

A. Heat exchanger capacity shall be rated in accordance with AHRI 400.

PART 2: PRODUCTS

2.1 PLATE HEAT EXCHANGER

- A. Heat exchanger shall be plate and frame type factory-assembled and tested.
- B. Construction shall be of 316L stainless steel plates, minimum thickness of 0.5 mm, formed into herringbone patterns mounted between a fixed and movable carbon steel head plate with grille rods and tie bolts. Molded one-piece mechanically rated EPDM gaskets shall be installed between stainless steel plate sections. Piping connections shall be ANSI flanged for 150 psi flange connections.
- C. Heat exchanger shall be a double-wall design, suitable for use with potable water.

- D. Frame assembly shall be bolted carbon steel construction with no requirement for field welded reinforcement of stiffeners. Frame assembly shall be provided with epoxy-coated finish or two coats of polyurethane paint finish. Aluminum or stainless steel shroud shall cover entire assembly.
- E. Heat exchanger shall have a maximum of four (4) piping connections.
- F. Complete assembly shall be assembled and tested in accordance with ASME Code, Section VIII, Division I, and stamped for a design pressure of 150 psig for both hot and cold sides. Test pressure shall be at least 150% of design pressure listed.
- G. Frame shall be sized for the capacity to accommodate a minimum of 20% future additional plates.
- H. Heat exchanger shall be Lochinvar IPW or equivalent by Sondex, Bell and Gossett, Mueller, Graham, or Alfa-Laval.

PART 3: EXECUTION

- 3.1 INSTALLATION
 - A. Install heat exchanger in accordance with manufacturer's instructions and drawing details.
 - B. Unit shall be hydrostatically tested for working pressure in accordance with the ASME Code. Any leaks shall be repaired, and the unit retested with a letter from manufacturer's representative witnessing the test.

PART 1 - GENERAL

1.1 SCOPE

- A. This section applies to all Sections of Division 26.
- B. The general provisions of the contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this section and in all sections of this Division.

1.2 WORK INCLUDED

- A. Provide all labor, tools, and materials required for a complete and fully operational installation, as described on the drawings or in the specification.
- B. The work shall be installed in a neat and workmanlike manner.

1.3 DEFINITIONS

- A. "Provide": furnish and install, complete and ready for operation.
- B. "Furnish": Supply, deliver to job site, protect and store.
- C. "Install": receive, mount, and connect, complete and ready for operation.
- D. "Wiring": wires and cables installed with all required raceways, connectors, and fittings.
- E. "Concealed": not exposed to view; embedded in masonry or other construction; in furred spaces or above suspended ceilings; below grade.
- F. "Exposed": not concealed; not embedded or installed underground; under raised floors; inside trenches, tunnels, basements, inside built-up HVAC equipment, crawl spaces, and accessible attics.
- 1.4 CODES, RULES, AND REGULATIONS
 - A. Comply with the following:
 - 1. Local codes enforced by the local inspection authority.
 - 2. The edition of the National Electrical Code being enforced for this project by the local inspection authority.
 - 3. All applicable laws and ordinances.
 - 4. The rules and regulations of electric utility company serving the project applicable to the installation of service and metering equipment.
 - 5. The rules and regulations of the telephone company serving the project applicable to the work required for routing telephone service into the facility.

B. Give all necessary notices, obtain all required permits, and pay all inspection and other fees imposed by Authorities Having Jurisdiction over the work.

1.5 MATERIALS

- A. All material shall be new, and shall comply with the indicated standards.
- B. All material shall be UL labeled or UL listed, except where the material is of a type not included in the UL listing service, in which case the material shall comply with other applicable industry standards and the contractor shall provide any examinations or certifications required by the local inspection authority in lieu of UL listing.
- C. All material shall be of a suitable type and rating for the intended use, and shall be installed in conformance with the instructions and recommendations of the manufacturer.

1.6 DRAWINGS

- A. The drawings are schematic in nature and do not indicate all of the required details of the work. All materials customarily considered to be a part of the electrical work and normally required for a complete and operational installation, shall be provided without additional cost to the Owner.
- B. Refer also to the drawings of all other trades to coordinate the electrical installation.
- C. Equipment of other trades is shown schematically on the electrical drawings. Examine the drawings of the trade providing the equipment before roughing in the connections for it. Connect the equipment where actually installed, including wiring through any line voltage controllers, without any additional cost to the Owner.
- D. Prior to roughing in circuits for equipment furnished by other trades, and prior to releasing for manufacture panelboards or starters feeding such equipment coordinate the electrical provisions being planned with the trade providing the equipment and submit any conflicts in writing.

1.7 SUBMITTALS

- A. Submit shop drawings in the manner and form described elsewhere in the contract requirements.
- B. Submittals are required for material as noted in other sections of this division.
- C. Check shop drawings prior to submission and provide date and signature of checker on each item. Note all corrections. Note any requested deviation from the drawings or specification, or if none, then so indicate. The Architect shall return documents without review where submitted without prior review by the contractor.
- D. Review of submittals will be only for general conformance with the design concept indicated on the drawings and in the specification and general compliance with the information given in the Contract Documents. Review will be made only of information clearly and specifically indicated in the submittal, and does not imply the acceptability of details, which are not so described in the submittal. Approval of a specific item shall not include approval of an assembly of which the item is a component. Contractor is responsible for: dimensions to be confirmed and correlated at the jobsite; information that pertains solely to the fabrication processes or to the means, methods, techniques, sequences and procedures of construction; coordination of the Work of all trades; and performing all work in a satisfactory manner.

E. Review of the submittal documents by the Architect does not relieve the contractor of the responsibility to comply with all requirements of the Contract Documents.

1.8 PROJECT CLOSEOUT

- A. Furnish closeout documents in the manner and form described elsewhere in the Contract Documents.
- B. Closeout documents shall include the following:
 - 1. Final shop drawings.
 - 2. As-built drawings including as-built field layout drawings.
 - 3. Operation and maintenance manuals.
 - 4. Receipts from the Owner stating that he has received satisfactory operational demonstrations and instruction for electrical systems.
 - 5. Signed receipts from the Owner for spare parts and materials that are specified to be furnished.
 - 6. Written guarantee.
 - 7. All required certifications, including certificate of inspection approval of the code-enforcing authority.
 - 8. All required test reports (include in operations and maintenance manual).

1.10 AS-BUILT DRAWINGS

- A. Provide as-built drawings in the manner and form described elsewhere in the Contract Documents.
- B. As-built drawings shall be maintained at the jobsite, and shall be available for review during construction.
- C. Record the final arrangement of the work and exact locations of the work as installed. Provide photographs of buried grounding work prior to backfill of trenches.
- D. As-built drawings shall be kept current during the course of construction of the work.
- E. Panel directories shall be updated to reflect the actual room numbers.

1.11 OPERATION AND MAINTENCE MANUALS

- A. Provide a minimum of five (5) copies of operation and maintenance manuals in the manner and form described elsewhere in the contract requirements. Manuals shall be typewritten, indexed, tabbed, and loose leaf bound in heavy duty 3-ring binders.
- B. Manuals shall include the following:
 - 1. Operating instructions customized to this specific project
 - 2. Maintenance instructions

- 3. Parts list
- 4. Descriptive literature
- 5. Location, telephone number and contact information of contractors, distributors, dealers and authorized service agents.
- 6. Test reports and certifications.
- 7. Record copies of all shop or submittal drawings and data
- 8. Copies of all software on diskette or compact disk, licensed to the Owner.
- C. Maintenance instructions and parts lists shall include the most detailed and advanced publications available from the equipment manufacturer.
- D. Demonstrate the operation of the equipment to the Owner, including instruction in its use and operation. Provide instruction by manufacturers representatives where specified.
- E. Provide operation and maintenance manuals for equipment and systems as specifically by the sections in Division 26.

1.12 SPARE PARTS

- A. Furnish spare parts as specified by the sections in Division 26.
- B. Turn over spare parts to Owners representative. Store on site as directed by the Owner. Obtain written receipt detailing specific spare parts turned over and submit with close-out documents.
- C. Replace at no cost to the Owner any spare parts used from the Owners stock prior to substantial completion or for warranty related repairs.

1.13 GENERAL TESTING

- A. Test all parts of the work to verify compliance with the drawings and specification.
- B. Verify tightness of all mechanical and electrical connections.
- C. Verify integrity of all wiring systems to assure continuity, absence of unintentional grounds, and integrity of required grounds.
- D. Perform any required special factory or field testing as specified in the other sections of this division. Provide all wiring, instruments, and personnel required to complete these tests.
- E. Where other requirements of this division require testing in the presence of the Architect, provide at least seven (7) business days advance written notice of such testing to the Architect.
- F. Where other requirements of this division require submission of written records of tests and test results, accumulate and submit all such reports and include as a separate section in the operations and maintenance manuals described elsewhere in this section.

PART 1 - GENERAL

1.1 GENERAL

- A. This section covers items of work required by more than one section of Division 26 Electrical.
- B. Refer to other Divisions for requirements pertaining to:
 - 1. Cutting and repairing
 - 2. Concrete
 - 3. Field painting
 - 4. Equipment furnished under other Divisions and installed under this Division

1.2 SUBMITTAL DOCUMENTS

A. Provide manufacturer's data sheets with complete description of all components, catalog numbers, specific details of applicable UL listings, and detailed line drawings of fireproofing methodology to be used for each type of penetration.

PART 2 - PRODUCTS

2.1 CONCRETE INSERTS

- A. Manufacturers:
 - 1. B-Line.
 - 2. Grinnell.
 - 3. Hohmann & Barnard.
 - 4. Kindorf.
 - 5. Unistrut.

2.2 DRILLED ANCHORS

A. Manufacturers:

- 1. Grinnell.
- 2. Hilti.
- 3. Rawl.
- 4. Red-Head.
- B. All metal, heavy duty, non-caulking, expansion bolt anchor equivalent to Rawl #9650 Series.
- C. Minimum size used shall be 1/4" machine thread.

2.3 METAL FRAMING CHANNEL

- A. Manufacturers:
 - 1. B-Line.
 - 2. Kindorf.
 - 3. Power-Strut.
 - 4. Super-Strut.
 - 5. Unistrut.
- B. 1-5/8" x 1-5/8", 12 Gauge.
- C. Use appropriate fittings of same manufacturer.

2.4 NAMEPLATES

- A. Provide engraved plastic equipment nameplates for all new disconnects.
- B. Nameplates for individually mounted safety switches shall state load served, circuit number, voltage and phase.

2.5 FIREPROOFING

- A. All fireproofing materials shall be the product of one manufacturer and shall be U.L. listed for the type of application where applied.
- B. Provide caulk, expanding foam, putty, rigid boards, tape and packing as required by the U.L. listing for the type of penetration being fireproofed.

- C. Fireproofing of sleeves, cable trays, troughs, and nipples to be used for low voltage cables shall be indefinitely non-hardening and removable with common hand tools.
- D. Fireproofing for penetrations of floor slabs shall also be waterproof for standing water in a nonfire condition.

PART 3 - EXECUTION

3.1 SUPPORTS

- A. All work shall be supported from structural elements of the building, except ceiling mounted equipment such as light fixtures, detectors, remote lamps, which shall be supported from ceiling support members independent of ceiling tiles.
- B. Size and spacing of supports shall be determined by the load to be supported such that the working load of supports will not exceed a safety factor of 4:1.
- C. Spacing intervals of supports shall in no case exceed intervals required by applicable codes.
- D. Plastic anchors, non-removable drive-in type expansion anchors and power actuated tool installed anchors are not acceptable.
- E. Work under this division shall not be supported from piping, ducts, or work of other trades, unless specifically noted on the drawings or with the written permission of the architect.
- F. Drilled anchors in sides of concrete joists shall be at least 3" from bottom of joist in the vertical plane.
- G. Provide drilled expansion bolt anchors to support all material mounted on masonry construction.
- H. All hardware, nuts, bolts, channel, braces, etc., used on exterior of building shall be galvanized.
- I. Rod supports shall be constructed of minimum 3/8" nominal continuously threaded rod of a continuous length. Use of rod couplings to extend the length of hanger rod shall not be allowed.
- J. Work installed under Division 26 supported from or attached to structural steel members shall not be welded to steel member but shall be attached by clamping a device manufactured specifically for this purpose.

3.2 EQUIPMENT OF OTHER TRADES

- A. Provide all power wiring and connections for all electrically operated equipment. Power wiring includes wiring through any line voltage control devices, such as thermostats and manual starters.
- B. Phase connections of motors shall provide proper motor shaft rotation.

C. Starters and contactors furnished under other divisions, except those furnished as an integral part of the equipment, shall be installed under this division.

3.3 EQUIPMENT CONNECTIONS

- A. Connections to motors and other vibrating equipment shall be made with a short length of liquidtight flexible conduit, minimum 18", installed in a manner to permit movement of equipment.
- B. For floor-mounted equipment, which is fed overhead and not located adjacent to a wall or column, provide a rigid conduit standpipe from floor to ceiling with a floor flange. Provide appropriate cast conduit "tee" fitting in standpipe for connection of equipment.

3.4 MISCELLANEOUS WORK

A. Protect work from damage and from entry of concrete, moisture, and other foreign material.

3.5 FIREPROOFING

A. All penetrations of fire rated walls, slabs, partitions, and ceilings shall be fireproofed with a U.L. listed system that will maintain the original fire rating of the penetrated structure.

PART 1 - GENERAL

1.1 EXISTING CONDITIONS

A. Prior to removal of existing work, and prior to the installation of conflicting new work, give written notice to the Architect where unforeseen existing conditions are discovered that affect the indicated work.

1.2 ELECTRICAL REMOVAL

- A. Remove, relocate, and extend existing installations to accommodate new construction.
- B. Remove abandoned wiring to source of supply.
- C. Remove exposed abandoned conduit, including abandoned conduit above accessible ceiling. Cut conduit flush with walls and floors, and patch surfaces.
- D. Disconnect abandoned outlets and remove devices. Remove abandoned outlets if conduit servicing them is abandoned and removed. Provide blank cover for abandoned outlets that are not removed.
- E. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing electrical installations that remain active.
- H. Extend existing installations using materials and methods as specified.
- I. Clean and repair existing materials and equipment that remain or that are to be reused.
- J. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- K. Unless otherwise indicated on the drawings, wire, conduit, and hanging materials being removed shall become the property of the Contractor and shall be removed from the jobsite as directed elsewhere in the Specification. Owner shall identify what equipment removed shall remain the property of, and be turned over to, the Owner.
- L. Coordinate with other divisions of work and disconnect power feeds to motors, heaters, or other electrically operated equipment, as required for the demolition work of others.

1.3 CONTINUITY OF SERVICE

A. Make all arrangements with the University, for work requiring installation, disconnect and reconnect of the existing service or metering equipment.

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers:
 - 1. Building Wire
 - 2. Wiring Connectors and Connections.

1.2 QUALITY ASSURANCE

- A. All wire and cable shall be delivered to the jobsite in original unbroken packages, cartons or reels, with the manufacturer's name, UL label, and characteristics of the product plainly visible.
- B. Wire or cable with defective or damaged insulation or jackets shall not be installed. Where damage, such as cuts, gouges, or slices, is discovered in the insulation or jacket while being installed, the damaged wire or cable shall be removed, and replaced. Field taping or other repair of damaged wire or cable is not acceptable.

PART 2 - PRODUCTS

2.1 BUILDING WIRE

- A. Conductors:
 - 1. Material: copper, 98% conductivity.
 - 2. Construction:
 - a. AWG 10 and AWG 12: stranded only
 - b. AWG 8 and larger: stranded unless otherwise detailed on the drawings.
 - c. AWG 14 and smaller: stranded (control use only).
- B. Insulation:
 - 1. Type THWN/THHN-2, dual-rated.
 - 2. Type XHHW: for underground secondary service entrance.

- 3. Type SFF: for wiring inside of luminaries.
- 4. Type SIS: for control wiring inside switchboards
- C. Voltage Rating: 600
- D. Color Coding:
 - 1. Unless contrary to requirements of local codes, the following color code shall apply:

	120/208V	277/480v
Phase A	black	brown
Phase B	red	orange
Phase C	blue	yellow
Neutral	white	gray
Ground	green	green

- 2. Isolated Ground Conductor color code: AWG 10 and smaller: green with yellow stripe in insulation. AWG 8 and larger: continuous green tape and two bands yellow tape adjacent to each other.
- 3. Color-coding of branch circuit neutral conductors: Where multiple branch circuit conductors of different phases, each with an associated neutral conductor, are installed within the same conduit, provide color coding of each neutral to match the associated phase conductor.
- 4. If local codes require other than these color codes to be used, the local codes shall be complied with.

- 5. Color code shall be indicated by:
 - a. AWG #10 and smaller: insulation color
 - b. AWG #8 and larger: colored tape applied at all terminations, and junction boxes, pull boxes and manholes.
 - c. Ground conductors shall be color coded along entire length where visible inside boxes and equipment.
- E. Accepted Manufacturers:
 - 1. Pirelli
 - 2. Southwire
 - 3. Superior Essex
 - 4. American Insulated Wire Corp
- F. All cable shall jbe manufactuered in the USA.
- 2.2 600 VOLT ACCESSORIES
 - A. Conduit wedges: 0-Z/Gedney Type "S"
 - B. Terminations, power connections, splices, taps:
 - 1. Splices: Compression type, copper, insulated with heat shrink sleeves.
 - 2. Taps #8 and larger: Compression type copper or copper alloy with snap-on insulation cover designed for the specific tap. Insulation displacement type fittings are not acceptable.
 - 3. Taps #10 and #12: twist-on insulated spring type connectors (i.e., Buchanan B-4) or squeeze-on insulated connector (i.e. 3M #560)
 - 4. Terminations: feeder cable to bus bar: copper or copper alloy compression lug, two bolt hole tongue if mounting space allows.
 - 5. Terminations: feeder cable to device or other condition where compression lugs mechanically will not fit: copper alloy mechanical lug, T&B "Locktite" series.
 - 6. Manufacturers:

- a. Burndy
- b. 0-Z/Gedney
- c. T&B
- d. Illsco
- e. Square D
- f. Panduit
- g. Buchanan
- h. 3M
- i. Ideal
- C. Terminations: Control Conductors:
 - 1. Compression Lug: insulated, T & B "StaKonâ" or equal
 - 2. Terminal Strip: barrier style, screw type, suitable for wire size and voltage applied.
- D. Wire Lubricants:
 - 1. Lubricant used shall be certified by conductor manufacturer to be satisfactory for use with the specific conductor insulation.
 - 2. Approved material:
 - a. Ideal "Yellow 77"
 - b. Ideal "Yellow 77 Plus"
 - c. 3M wire pulling lubricant
- E. Wire markers: Permanent, machine printed, self-laminating vinyl, T & B Type "WSC", Burndy Type "XC".
- F. Feeder Identification Labels: Engraved black color laminated plate attached to conductors with nylon tie, or T & B TY-553M marked with WT-163M-1 pen.

PART 3 - EXECUTION

3.1 SIZES, QUANTITIES, TYPES

- A. Building Wire:
 - 1. AWG 12 minimum, except as noted below.
 - 2. 120 Volt circuits with homerun length over 75 feet shall have AWG 10 minimum homerun conductors.
 - 3. 277 Volt circuits with homerun length over 200 feet shall have AWG 10 minimum homerun conductors.
 - 4. All circuits shall be installed as shown on the drawings. Up to six current carrying conductors may be combined into a single conduit as permitted by NEC.
 - 5. Type THHN-2/THWN shall be used for all branch circuits, AWG 12 through AWG 8. Conductors shall be stranded, unless otherwise noted on the drawings. Where stranded wire is to be connected to wiring devices or other equipment whose terminals are not rated for use with stranded wire, "Stakon" type terminals shall be used on the wire.
 - 6. Conductors larger than AWG 8 installed above grade shall be Type THHN-2 or THWN. Where installed in conduit run below grade, shall be type THWN or XHHW.
 - 7. Where branch circuit conductors enter the wiring compartment of lighting fixtures, the insulation used on that segment of the branch circuit shall be UL listed for application at the temperature that will be encountered in the fixture.
 - 8. General-purpose control conductors: AWG 14 minimum, stranded, protected by control circuit overcurrent protection rated not greater than or set at the rated ampacity of the conductor.
- B. Flexible Cords:
 - 1. AWG 16 minimum
 - 2. Rated for the applied voltage and load
 - 3. Contain full size ground conductor

3.2 INSTALLATION

A. Building Wire:

- 1. Conductors shall not be pulled in an ambient temperature lower than 15° F.
- 2. Adequate wire lubricants shall be used to minimize pulling tension.
- 3. Conductors shall not be bent, either manually or with bending tools, in a manner that puts excessive stress on insulation or causes it to buckle. Avoid bending to a radius less than manufacturers recommended minimum. Conductors with visibly damaged insulation shall be replaced at no additional cost to the Owner.
- 4. Conductors installed in vertical raceways shall be supported by wedge fittings attached to the conduit on intervals as prescribed by code. Provide suitable sized pull box enclosures as required to contain the support wedges.
- 5. All terminations of feeder conductors not made directly on device terminals shall be made with compression lugs installed in accordance with the manufacturers instructions and with a compression tool approved for the terminator used.
- 6. Feeder conductors shall be individually identified at each end and at all intermediate pull boxes and other accessible locations with feeder designation, source, load, voltage, and phase.
- 7. General-purpose control conductors and all special systems conductors shall be identified on each end with a unique number or designation. This identification shall be recorded on the contractor's as-built drawings.
- B. Flexible Cords: Shall be installed with cord grip and strain-relief connectors.

3.3 TESTING

- A. Cable Test:
 - 1. Megger test all feeders.
 - 2. Megger test of all feeders shall be accomplished before energizing circuits. Test shall be phase to phase and phase to ground.
 - 3. Submit a written tabulation of the results of each test to the Owner's representative for review. Replace any cable with installed insulation resistance of less than accepted industry standards.
- B. Replacement of Conductors
 - 1. Replace conductors, determined by testing as not acceptable, without additional cost to the Owner.

PART 1 - GENERAL

- 1.1 DESCRIPTION
 - A. Grounding System: Grounding of all electrical equipment and raceways.
 - B. Miscellaneous grounding, installation of separate ground bus bars and miscellaneous bonding.

PART 2 - PRODUCTS

- 2.1 BUILDING GROUNDING SYSTEM
 - A. Conductors:
 - 1. 98% conductivity copper, solid or stranded, sizes and types as indicated on the drawings.

PART 3 - EXECUTION

- 3.1 EQUIPMENT GROUNDING CONDUCTORS
 - A. Separate Grounding Conductor: All branch circuits and feeders operating at higher than 50 volts to ground shall have an insulated equipment ground conductor, green color, sized in accordance with the National Electrical Code.

PART 1 - GENERAL

1.1 GENERAL

A. This section describes conduit and related fittings. Other raceway types are specified in other sections.

1.2 SIZE

- A. Minimum conduit size shall be 3/4".
- B. Conduit size may be increased to facilitate pulling of conductors.

1.3 COORDINATION WITH WORK OF OTHER TRADES

- A. Coordinate the conduit layout with the work of other trades. Conduits shall be located to avoid interference with equipment that requires access, maintenance, adjustment, or repair. Conduits shall not restrict the required working clearance around such equipment.
- B. Conduits feeding, or connecting to, equipment provided by other trades shall not be installed until such equipment is installed or until the trade providing the equipment furnishes specific rough-in instructions.
- C. Conduits shall be concealed, unless otherwise indicated.

1.4 SCOPE OF CONDUIT WORK SHOWN ON THE DRAWINGS

- A. The conduit layout indicated on the drawings is schematic and is not intended to show the exact location of conduits unless specifically dimensioned. Locate conduit as required by the architectural and structural details of construction and by the coordination with the work of other trades.
- B. Provide all fittings, offsets, supports, pullboxes and other components of the conduit system as required for a complete raceway system.

1.5 QUALITY ASSURANCE

- A. The conduit shall be new, of uniform quality and appearance, and marked with U.L. listing and name of manufacturer.
- B. All seams shall be smooth, without splits, clean, and with threads protected when delivered to or stored on site.

C. Provide fittings designed and U.L. listed for use with the specific wiring method used.

PART 2 - PRODUCTS

- 2.1 RIGID METAL CONDUIT (TYPE RMC)
 - A. Manufacturers:
 - 1. Allied Tube & Conduit Corp.
 - 2. Jones & Laughlin
 - 3. Pittsburgh-Standard
 - 4. Republic
 - 5. Triangle Wire & Cable, Inc.
 - 6. Wheatland Tube Co.
 - 7. Youngstown
 - 8. ETP
 - 9. Robroy Industries, Inc.
 - B. Material: Full weight, steel, standard size, hot dipped galvanized outside, galvanized or coated inside, threaded ends.
 - C. Fittings:
 - 1. Couplings: Continuous threaded, furnished by the manufacturer with conduit. For IMC, ETP "Uni-Swivel" couplings are acceptable.
 - 2. Threaded joint compound: Fel-Pro C5A.
 - 3. Terminations (dry locations): Double locknuts with insulated throat, metallic grounding bushing, 0-Z/Gedney type "BLG".
 - 4. Terminations (wet locations): Watertight hubs, 0-Z/Gedney Type "CHM", or conduit hubs integral with equipment.

2.2 INTERMEDIATE METAL CONDUIT (TYPE IMC)

- A. Manufacturers: same as for RMC
- B. Material: Lightweight steel, standard size, hot dipped or electro-galvanized zinc outside and galvanized or enamel coated inside, threaded ends.
- C. Fittings: same as for RMC
- 2.3 RIGID NON-METALLIC CONDUIT (TYPE RNC)
 - A. Manufacturer:
 - 1. Carlon, Division of Lamson & Sessions Co.
 - 2. Sedco
 - 3. Centex, Inc.
 - 4. Heritage Plastics
 - 5. Certainteed Corp.
 - B. Material: PVC Schedule 40, unless otherwise indicated, rated for use with 90°C conductors.
 - C. Where PVC being run under slabs, or grade, turns up through the slab, or above grade, the elbow and vertical section of conduit from the elbow to the termination of the conduit shall be RMC, or IMC, as protection against the exposed conduit being damaged.
 - D. Accessories: Fittings, couplings, cement, and other accessories shall be of the same manufacture as the PVC conduit that they are used with.
- 2.4 ELECTRICAL METALLIC TUBING (TYPE EMT)
 - A. Manufacture: same as for RMC.
 - B. Material: Thin-wall steel, galvanized outside, coated inside.
 - C. Fittings:
 - 1. For EMT (Sizes 1.25" and smaller):
 - a. Couplings: All steel, compression type, concrete tight where installed in concrete, Raco, T&B, Midwest, or Steel City, O-Z/Gedney

- b. Connectors: All steel, compression type, with nylon throat; Raco, T&B, Midwest, or Steel City.
- 2. For EMT (Sizes 1.50" and larger):
 - a. Couplings: All steel, compression type, of same manufacture.
 - b. Connectors: All steel, compression type, of same manufacture, and insulated throat, metallic grounding bushing, 0-Z/Gedney Type "BLG".

2.5 FLEXIBLE METAL CONDUIT (TYPE FMC)

- A. Manufacture:
 - 1. AFC Cable Systems, Inc.
 - 2. Alflex
 - 3. Electri-Flex Co.
 - 4. Steelflex Electro Corp.
- B. Material: galvanized steel, Continuous single interlocking strip.
- C. Fittings: T&B "Tite-Bite" series, Midwest Fittings.
- 2.6 LIQUIDTIGHT FLEXIBLE METAL CONDUIT (TYPE LFMC)
 - A. Manufacture: same as for FMC.
 - B. Material: Flexible metallic conduit with PVC jacket, type "UA", with integral copper grounding conductor suitable for use as equipment grounding conductor.
 - C. Fittings:
 - 1. Material: Steel, or malleable iron, liquid-tight connector with insulating throat liner (use bushing above 1.25").
 - 2. Manufacture: T&B, Midwest Fittings, O-Z/Gedney.

2.7 EXPANSION FITTINGS AND ACCESSORIES

A. Expansion fittings:

- 1. For conduit not embedded in concrete while passing across building expansion joint, provide 0-Z/Gedney type AX for GRC and IMC or type TX for EMT. Provide bonding jumper.
- For conduit embedded in concrete while passing across building expansion joint, provide 0-Z/Gedney type DX expansion joint or type AXDX if required by the degree of expansion possible.
- B. Conduit bodies:
 - 1. Used for pulling conductors: Crouse-Hinds LBD series through 2.00" and LBNEC Series 2.50" and above.
 - 2. Used for motor connection: Crouse-Hinds condulet "T" series.
- D. Pull strings for empty conduits shall be equal to Greenlee 430 poly pull line.

PART 3 - EXECUTION

3.1 GENERAL

- A. Run exposed conduits parallel or perpendicular to structural elements.
- B. Two or more raceways run together shall be installed on trapeze type gang hangers. Such raceways assemblies shall be run parallel or perpendicular to structural elements.
- C. Where bends are made in a rack of exposed conduits, field bent concentric elbows shall be used.
- D. All wiring shall be installed in conduit, unless plenum rated cable is specified in other sections to be installed without conduit or, unless the wiring is shown to be in a wireway or cable tray.
- E. Unless specifically noted on the drawings all raceways shall be concealed in walls, floor slabs, topping slab on floor, or in ceiling plenums.
- F. Apply threaded joint compound on all Type RMC and Type IMC threaded joint connections.

3.2 SCHEDULE

- A. Unless otherwise required, provide RMC or IMC for the following applications:
 - 1. Exposed stub-ups from floor.
 - 2. In poured concrete walls and columns.
 - 3. Where subject to damage.

- 4. Exposed on exterior of building.
- 5. Exterior circuits under roadways.
- 6. Feeder or service conduits under slab, or in grade, where concrete encased RNC PVC is not used.
- B. Provide EMT in dry locations only for the following applications:
 - 1. Concealed work in slabs, walls, and ceiling plenums.
 - 2. Branch circuit feeder wiring not otherwise required to be run in RMC or IMC.
 - 3. Signal or communication raceways (other than underground)
- C. Provide RNC PVC for the following applications:
 - 1. Concrete encased duct banks where specifically indicated.
 - 2. Concealed in or under slab.
 - 3. Concealed in masonry wall.
 - 4. Underground single grounding conductors.
- D. Flexible conduit is permitted only where concealed above suspended ceilings for connections of light fixtures, tele-power poles, and similar equipment and shall not exceed 3'-0" length. Luminary fixture whips may be 6'0" in length.
- E. Liquid-tight flexible metal conduit (LFMC) shall be used for all connections to vibrating equipment, such as motors and transformers, and where flexible conduit is indicated on the drawings, except as noted above. Use Type FMC in plenum spaces.

3.3 INSTALLATION

- A. All threaded conduits shall be terminated with specified bushings.
- B. Conduit joints:
 - 1. Ream end of conduit smooth.
 - 2. Conduit ends shall meet in coupling.
 - 3. Provide unions where required, of the Erickson Type.

- 4. Provide joint compound on the male threads of RMC and IMC conduit.
- C. Use double locknuts at threaded conduit terminations.
- D. The conduit system shall be left free of all debris, water and foreign material. Plug or cap all conduits with exposed ends to prevent entrance of concrete or other foreign material. Pull a cleaning swab through all conduits prior to pulling conductors.
- E. Conduits run parallel to, or crossing hot pipes, shall not be closer than 0'-6" to hot pipe.
- F. Anchors or supports in waterproof walls shall be of the type and methodology directed by the architect.
- G. Empty EMT raceways shall be terminated with connectors, and if over 1.25", specified bushings.
- H. Raceways in accessible ceiling plenums shall not be installed closer than 8" to ceiling.

3.4 ACCESSORIES

- A. Pull wires: provide nylon pull wire in all empty conduits and at all data and telephone outlet locations.
- B. Expansion fittings: provide at all building expansion joints.
- C. Fire seals: provide where conduit passes through a floor slab (other than slab on grade) and where conduit passes through fire-rated masonry walls, unless cast in place.

3.5 IDENTIFICATION

- A. All exposed conduits 2 inches and larger shall be identified with markers 20 feet on center.
- B. Refer to 26 0563 for additional requirements.

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers pull boxes, outlet boxes, and junction boxes.
- B. Refer to Section 26 27 26 Wiring Devices for additional requirements for outlet boxes for wiring devices.

1.2 APPLICATIONS

A. All splices, pull boxes, taps, connections, devices, etc., shall be installed using boxes of the appropriate type, designed and approved for the intended purpose.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Box sizes specified are minimum, and shall be increased where required by code due to the number of conduit entries, conductors, devices, or taps in the box.
- B. All boxes shall be made of galvanized sheet steel, of code gauge thickness, but no less than 1/16" thick or 14 Gauge.
- C. Outlet box covers shall be attached by means of machine screws. Self-tapping sheet metal screws are not acceptable.

2.2 MANUFACTURERS

- A. Outlet boxes: Steel City, Appleton, Raco
- B. Cast boxes: Crouse-Hinds, Appleton

2.3 SCHEDULE

A. Schedule indicates box type; select actual box and plaster ring to suit actual conditions:

	BOX	COVER
Recessed device outlet	RACO 683	RACO 770
Recessed tele/data outlet	RACO 683	RACO 770

Emory Woodruff Residence Hall Flue Expansion						
SG-21290EMOWDR						
Recessed wall mounted fixture	RACO 683	RACO 767				
Flush concrete outlet	RACO 272	RACO 893				
Flush concrete junction	RACO 272	RACO 892				
Junction box above ceiling	RACO 257	RACO 832				

Exposed device outlet	C/H "FS"	C/H DS32
Exposed fixture outlet	C/H "GRFX"	
Flush ceiling fixture	RACO 683	RACO 767

2.4 SPECIALTIES

- A. Boxes installed in concrete shall be UL listed for such use.
- B. Through-wall boxes are not acceptable.
- C. Provide 3/8-fixture stud and box supported from structure when required by weight of fixture being supported.
- D. Junction boxes installed above ceilings shall be plenum type.

2.5 PULL BOXES AND JUNCTION BOXES

- A. In dry locations, boxes shall be galvanized sheet steel, minimum 12 gauge, with machine screw covers, and welded construction. Welds shall be slag-free and cold galvanized.
- B. In damp locations or outdoors, unless otherwise shown on the drawings, boxes in steel raceway runs shall be galvanized cast iron, with gasketed covers and conduit hubs, or drilled and tapped. Boxes in Type RNC PVC raceway runs shall be PVC with gasketed cover.
- C. All boxes shall be rated for their application, such as sidewalk, or light vehicle traffic.
- D. Provide insulated cable support racks in feeder pull boxes where conductor length exceeds 48" inside pullbox.

PART 3 - EXECUTION

3.1 GENERAL

A. Refer to other sections for mounting heights of boxes for devices and equipment.

- B. Boxes shall be located clear of other trades, and shall be accessible.
- C. Coordinate the exact location of ceiling outlet boxes and boxes concealed above ceilings, with ductwork and piping so that the box will be accessible.
- D. All required pull boxes are not indicated on the drawings. Provided boxes as determined by actual field installation and as required for a complete installation.
- E. Using a permanent, waterproof, wide black marker, clearly label cover of all branch circuit junction boxes, and smaller pull boxes, with panel and circuit number of circuits contained in, or passing through, the box.
- F. Paint all new junction boxes with the following color code:
 - 1. Standard receptacle circuit unpainted
 - 2. Lighting, normal circuit White
 - 3. Fire Alarm, including jbox and conduit Red
 - 4. Emergency Lighting Yellow
 - 5. HVAC Blue
- G. Provide engraved "lamicore" nameplate on cover of each major feeder pull, or junction, box as specified under Section 26 05 63 Electrical Identification.

3.2 INSTALLATION

- A. Boxes shall be securely anchored in place, and shall be supported independent of the raceway system.
- B. Boxes installed in poured concrete shall be anchored to the formwork and protected against entry of any concrete.
- C. Boxes shall be set square and plumb with building elements.
- D. Outlets for ceiling mount fixtures shall be rigidly supported from the grid or structure with an assembly manufactured for this purpose.

PART 1 - GENERAL

1.1 SCOPE

- A. Identification nameplates and labels.
- B. Wire and cable identification markers.
- C. Conduit identification markers

PART 2 - PRODUCTS

- 2.1 NAMEPLATES AND LABELS
 - A. Equipment connected to non-essential supply (commercial power only): White letters on Black background.
 - B. Locations:
 - 1. Main Service and Distribution equipment over-current devices.
 - 2. Electrical distribution equipment enclosures.
 - 3. Motor Control Devices and Contactors.
 - 4. Disconnect switches.
 - C. Labels:
 - 1. Locations required:
 - a. All field equipment fed from 120/208 V power source.
 - b. All field equipment such as motors, control stations, etc.
 - E. Provide engraved plastic equipment nameplates for all new panelboards, motor control centers, starters, and disconnects include voltage, phase, feeder conduit/conductor size, origin of feeder connection and calculated AIC.
 - F. Nameplate wording shall be coordinated with final equipment identification nomenclature and approved by the owners' designated representative prior to installation.

- G. Letter Size:
 - 1. 1/4 inch letters: Identify individual equipment, and loads.
 - 2. 1/2 inch letters: Identify major electrical equipment and panelboards.

2.2 WIRE AND CABLE MARKERS

- A. Description: Non-ferrous identify tag or shrink type label.
- B. Locations: Each cable feeder, power circuit, and conductor in vaults, manholes, gutters, pull boxes, starters, outlet and junction boxes, control panels, panelboards, switchboards, etc., and each load connection.
- C. Legend: Each tag or label shall be typewritten with description listed below.
 - 1. Power and Lighting Circuits: Branch circuit or feeder number indicated on drawings.
 - 2. Control Circuits: Control wire number indicated on schematic and interconnection diagrams.

2.3 CONDUIT MARKERS

- A. Location: Furnish vinyl markers for each 2.00" or larger conduit longer than 6 feet for power circuits or Type MC Cable with 3/0 or larger conductors longer than 6 feet.
- B. Spacing: Adjacent to each termination at equipment and pull boxes and intermittently at 20 feet on center.
- C. Color: Use the following color-coding:
 - 1. 480 volt system: Orange color and black stencil, voltage in 1/2" black letters. At the source end, also indicate the load served in 1/2" black letters. At the load end, also indicate the circuit source identification in 1/2" black letters. At intermediate points, also identify both the circuit identification and load in 1/2" black letters.
 - 2. 208 volt system: White color and black stencil, voltage in 1/2" black letters. At the source end, also indicate the load served in 1/2" black letters. At the load end, also indicate the circuit identification in 1/2" black letters. At intermediate points, also identify both the circuit identification and load in 1/2" black letters.

PART 3 - EXECUTION

3.1 PREPARATION

A. Degrease and clean surfaces to receive nameplates and labels.

3.2 INSTALLATION

- A. Install nameplate and label parallel to equipment lines.
- B. Secure nameplate to equipment front using screws.
- C. Secure nameplate to inside surface of door on panelboards that are recessed in finished wall locations.
- D. Install conduit markers per Section 2.
- E. Stencil conduit markers or use adhesive letters or order pre-labeled. Handwritten entries that are neat and legible and not smeared are acceptable. Any conduit markers that that are determined not to be neat, legible, and free from smears shall be replaced to the satisfaction of the Architect.
- F. For other conductor color-coding, see Section 26 05 19 Low-Voltage Electrical Power Conductors And Cables.
PART 1 - GENERAL

1.1 GENERAL

A. This section describes separately mounted dry-type transformers.

1.2 SUBMITTAL DOCUMENTS

- A. Shop drawings: Indicate dimensions, taps, insulation class, K-rating, and connection diagram of windings.
- 1.3 OPERATION AND MAINTENANCE (O&M) DATA
 - A. Provide record copy of final submittal documents.
 - B. Provide manufacturer's published recommended procedures for preventative maintenance and repair.
 - C. Provide all information bound within the required Division 26 Master O&M manuals specified in another section.

PART 2 - PRODUCTS

2.1 MANUFACTURER:

- A. Eaton/Cutler-Hammer
- B. ABB/General Electric (ABB/GE)
- C. Schneider/Square D

2.2 CONSTRUCTION

- A. Dry-type, metal enclosed, self-cooled ventilated type, dead front, drip-proof, copper windings.
- B. Primary, secondary and tap connections shall be accessible from the front.
- C. Core and coil assembly shall be mounted to the enclosure framework on vibration isolators.
- D. Rated for 115° C rise, 220° C insulation system, and 40° C ambient.
- E. Two-winding type, three-phase, delta connected primary, grounded wye secondary.

- F. Transformer taps:
 - 1. Three-phase, 15 kVA and smaller: (2) 2.5% above and (2) 2.5% below.
 - 2. Three-phase, 30 kVA and larger: (2) 2.5% above and (4) 2.5% below.
 - 3. Single-phase: (2) 2.5% below.
- H. Noise Level: NEMA standard for each range of kVA ratings.
- I. Enclosure: NEMA Type 1, except where installation location requires use of an alternate NEMA Type enclosure.
- J. Shall meet the latest Department of Energy requirements.

PART 3 - GENERAL

3.1 PROTECTION

- A. Protect from moisture and debris entry and from physical damage
- B. Dry out transformer windings prior energizing.

3.2 MOUNTING

- A. Mount and support in accordance with the manufacturer's recommendations.
- B. Provide seismically designed supports and bracing where required by site geographic location and where installed adjacent to essential equipment that could be damaged by potential movement during seismic events.
- C. 15kVA and smaller ceiling-hung transformers shall be suspended using 1/2 inch threaded rod, with a suitable size channel iron frame base for supporting the transformer. Small wall-mounted transformers shall utilize manufacturer's wall-mount brackets where wall is suitable for supporting weight of unit.
- D. Mount on concrete housecleaning pads on floor, or on wall, or suspended from structural elements as indicated. Anchor floor-mounted units to concrete pad.
- E. Provide Mason Type "W" neoprene vibration pads between base of transformer and mounting surface.

3.3 CONNECTIONS

A. Connections shall be made using a short length of flexible metallic conduit, between feeder conduit, and primary disconnect where provided, and enclosure. Use liquid-tight flexible metallic conduit where located in areas suitable for such use.

B. Connect primary phases A, B, C to H1, H2, and H3 in that order. Connect secondary phases A, B, C to X1, X2, and X3 in that order. Color code conductors as described in other sections.

3.4 GROUNDING

- A. Provide a grounding electrode conductor (GEC) from the neutral terminal to the building main ground bus bar, to a main structural steel column, to a domestic potable water metallic pipe. Size per NEC, or as indicated on the drawings, and run in Type RNC conduit.
- B. Transformer neutral: Bond to the enclosure and frame using a manufactured length of flexible copper wire braid with factory lugs, sized per NEC, or as indicated on the drawings.

PART 1 - GENERAL

1.1 SCOPE

- A. This section covers the installation of new over-current protective devices in existing equipment.
- 1.2 DESCRIPTION OF WORK
 - A. Provide new over-current protective devices, hardware and associated components as required for a complete installation in existing switchboards and panelboards as indicated on the plans.

PART 2 - PRODUCTS

2.1 AVAILABILITY OF DEVICES

- A. Where a device is obsolete and the manufacturer does not offer an equivalent replacement device, provide written notice to the Architect.
- B. New device voltage and fault current interrupting ratings (SCCR) shall equal, or exceed, existing device ratings unless otherwise noted elsewhere in the specification or on the drawings.

2.2 HARDWARE

A. Bus bars, draw-out and plug-in assemblies, connectors, adapters, lugs, and other hardware shall be of the same type and manufacture as existing equipment. New closure panels and doors shall match existing equipment.

PART 3 - EXECUTION

- 3.1 EXTEND, MODIFY, BRACE AND INSTALL ALL NEW BUSING TO MATCH EXISTING BUSING.
 - A. All hardware, doors, panels and closure plates shall be mounted in alignment with existing equipment.
 - B. Provide engraved nameplates on all new circuits in switchboards and in power distribution panelboards.
 - C. Provide new typewritten directory in branch circuit lighting and receptacle panelboards where circuits have been modified under this scope of work.

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section describes panelboards as scheduled on the drawings as "Panelboards" and also referred to on the drawings and in the specification as "panel".

1.2 SUBMITTAL DOCUMENTS

- A. Provide a schedule of each panelboard demonstrating placement of branch breakers in accordance with the schedules on the drawings. Circuit numbering shall be indicated and configured as scheduled.
- B. Provide dimensioned drawings of panel can and panel cover detailing construction of hinged front cover. Gutter sizes shall be indicated.
- C. Provide ratings of each main and branch device, panelboard electrical characteristics, and assembly fault current rating.

1.3 OPERATION AND MAINTENCE MANUALS

- A. Provide record copy of submittal documents.
- B. Provide maintenance instructions, detailed drawings, and parts lists.
- C. Provide manufacturer's published recommended procedures for preventative maintenance, repair, and normal operation of the panelboards and all components.

PART 2 - PRODUCTS

2.1 CONSTRUCTION

- A. Branch circuit panels shall be factory assembled with bolt-on breakers.
- B. Bus shall be plated copper.
- C. Construction shall be dead front with separately mounted interior trim.
- D. Branch breakers shall be arranged as scheduled on the drawings.
- E. Multi-pole breakers shall be common trip. Tandem breakers shall not be furnished.

- F. Enclosure shall be galvanized sheet steel. End panelboards shall be blank without knockouts.
- G. All panels shall have hinged door-in-door trim. Factory paint cover with two coats of a standard gray color enamel.
- H. Provide flush lock and catch. Lock mechanism shall be metal construction.
- I. Gutter sizes:
 - 1. Manufacturers standard, unless otherwise required.
 - 2. Provide additional 8" gutter width with sheet metal barrier where feeder passes through panel can or is tapped in gutter.
- J. Provide ground bus bonded to enclosure.
- K. Where a panelboard is shown to be fed by more than one conductor per phase, an individual lug shall be provided for each conductor.
- L. Provide circuit breaker mounting hardware where a "space" is scheduled.
- M. Provide drip hood option.

2.2 MANUFACTURERS

- A. Eaton/Cutler-Hammer
- B. ABB/General Electric (ABB/GE)
- C. Schneider/Square D

PART 3 - EXECUTION

3.1 GENERAL

- A. Branch circuit conductors shall be run at right angles to enclosure sides, bundled neatly and laced with nylon Ty-Raps.
- B. Provide typewritten panel directories indicating location and type of load served by each branch circuit. At the top of the directory, type in bold letters the location in the building of the breaker which feeds the panelboard. Indicate all deletions and additions and provide date of change on the directory. The panel directory must reflect the actual room numbers.
- C. Conductors shall not be spliced within the panelboard enclosure. Branch circuit conductors not long enough to reach the scheduled branch circuit breaker shall be replaced.

- D. Tighten all factory connections, including breaker mounting hardware prior to energizing panelboard.
- E. All unused breaker mounting spaces shall be covered or blanked.
- F. Provide specified nameplate on panel front cover.
- 3.2 MOUNTING
 - A. Surface mount or flush mount, at locations as indicated on the drawings, at same height to top of trim, generally 6'-6", unless otherwise required by specific site conditions.

PART 1 - GENERAL

1.1 SCOPE

- A. This section describes switches, receptacles, faceplates, and other wiring devices.
- B. Outlet boxes are specified in another section.

1.2 STANDARDS

- A. All devices shall be UL labeled.
- B. All devices shall meet applicable NEMA wiring device standards.
- C. All special-purpose receptacles shall be NEMA Standard configuration.

1.3 SUBMITTAL DOCUMENTS

A. Submit manufacturer catalog cut sheets of wiring devices specified in this section.

1.4 OPERATION AND MAINTENANCE MANUAL

A. Provide record copy of device submittal incorporated into the project O&M Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURE

- A. Switches, receptacles, plates:
 - 1. Arrow-Hart
 - 2. Bryant
 - 3. Hubbell
 - 4. P&S/Legrand

2.2 DESCRIPTION

A. The color of all devices shall be gray.

- B. Switches, receptacles:
 - 1. Standard wall toggle switches for lighting circuits shall be heavy-duty, 20 Amp, AC only, nylon, quiet type, with ground bonding screw terminal, Hubbell #HBL1221 Series, back wired using screw and clamp.
 - 2. Duplex receptacles shall be heavy-duty, 125 volt, 20 amp, 3-wire grounding, nylon face, with self-grounding attachment, with ground bonding screw terminal, Hubbell #5362 Series, back wired using screw and clamp.
 - 3. Individual duplex receptacles on separate 20 Amp circuits shall be rated 20 Amp.
 - 4. Special purpose receptacles shall be of NEMA type indicated, heavy-duty, with nylon face where available.
 - 5. G.F.C.I. Type receptacles shall be rated 20 Amp, Hubbell #GF20 Series.
- C. Device plates/covers for interior application: Stainless steel, Hubbell Series to match existing.

PART 3 - EXECUTION

- 3.1 GENERAL
 - A. Refer to Section 26 0535, BOXES, for outlet box requirements.
 - B. All devices shall be installed in appropriate boxes designed for the purpose, in accordance with manufacturer's directions.
 - C. Adjacent outlets of any type, including dimmers and fan speed controls, shall be installed in multi-gang boxes with a single multi-gang faceplate.

3.2 INSTALLATION

- A. Locations, unless otherwise required by local codes or noted on the drawings (dimensions in center):
 - 1. Switches: 42 in. above finished floor, 4 in. from doorjamb on strike side of door.
 - 2. Receptacles: 1 ft. 6 in. above finished floor, except where indicated above a countertop.
 - 3. Telephone and data outlets: 1 ft. 6 in. above finished floor, except where indicated above a countertop.

- B. Grounding: Provide AWG 12, green color, insulated copper ground bonding jumpers for all switches and receptacles, bonded to the grounding screw provision within the box with separate grounding screw or lug.
- C. Low Voltage System Outlets: Provide minimum (1) 1.00" conduit stub up to accessible aboveceiling space, turned toward system source or above-ceiling system wiring pathway, as applicable. Where combination system box is used, provide separate raceway for each system type.
- D. Device Labeling (applies to branch circuit devices wiring outlets under this section):
 - 1. Provide adhesive backed label on each wall switch and receptacle device outlet coverplate indicating panelboard served from and circuit number (i.e.: L-6).
 - 2. Labels shall be made on 3/8" or ½" inch stock, black color letters with clear background.
 - 3. Label system shall be Brother "P-Touch" System or equivalent.
 - 4. Labels shall not be applied until final touch-up painting is complete and covers are permanently mounted.
 - 5. Provide labels using a black permanent marking pen on each associated receptacle box and switch box indicating panelboard number and circuit number.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes disconnect switches and fuses for other than devices furnished with integral current-limiting fuses, such as fused circuit breakers and motor circuit protectors.
- B. Spare fuses of all types are included in this section.
- C. Provide required fuses, including spare fuses, for all fusible equipment furnished under this division.

1.2 NAMEPLATES

A. Provide engraved "lamicore" nameplates for all disconnect switches, and individually enclosed circuit breakers, indicating the equipment served. Refer also to Section 26 05 63 - Identification For Electrical Systems.

1.3 SPARE FUSES

A. Provide (3) three spare fuses of each type and rating for all power and control fuses, including current-limiting fuses furnished as an integral part of fused circuit breakers or motor circuit protectors.

1.4 SUBMITTAL DOCUMENTS

- A. Required for all equipment specified by this section.
- B. Circuit breaker submittal shall indicate device ratings, including interrupting capacity, dimensions of enclosure, and wire bending space.

1.5 OPERATION AND MAINTENCE MANUALS

A. Provide record copy of all submittal documents and assemble as identified in another section.

PART 2 - PRODUCTS

- 2.1 GENERAL
 - A. All devices shall be UL labeled.

2.2 FUSES

- A. Manufacturer:
 - 1. Bussman
 - 2. Ferraz-Shawmut
 - 3. Little-Fuse
- B. Fuses applied on circuits operating at 250 Volts or less shall be 250 Volt rated.
- C. Fuses applied on circuits operating at 600 Volts or less shall be 600 Volt rated.
- D. All fuses shall have an interrupting capacity of 200,000 amps, RMS symmetrical, at rated voltage.
- E. Fuses for transformer feeders and motor branch circuits shall be dual-element time delay, current-limiting, Class J for 600 Amp and smaller, Class L for larger than 600 Amp.
- F. Fuses for feeders, control circuits, and other loads shall be fast acting, current limiting, Class J for 600 Amp and smaller, Class L. for larger than 600 Amp.

2.3 DISCONNECT SWITCH (SAFETY SWITCH)

- A. Manufacturer:
 - 1. Cutler-Hammer
 - 2. General Electric
 - 3. Siemens
 - 4. Square D
- B. Shall be of the fusible, or non-fusible type, as indicated on the drawings.
- C. Shall be heavy duty, quick-make, quick-break, HP rated, hinged cover dual interlocked with switch handle and with external interlock defeat mechanism, with provision for handle and door padlocking.
- D. In dry locations shall be Type NEMA 1 enclosed.
- E. In damp locations, or outdoors, shall be Type NEMA-3R, enclosed, except where the applied use requires an alternate Type NEMA enclosure rating.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Mount disconnects on building structural elements, or on auxiliary framing, with top at 6'-0" A.F.F. where allowed by surrounding conditions.
- B. Devices shall not be supported from, or mounted to, equipment of other trades unless approved in writing by the manufacturer of that equipment.
- C. Raceways connecting NEMA-3R enclosed devices shall be installed in such a manner as to prevent the entry of water. Raceways shall enter only the bottom of the enclosure.
- D. Provide engraved lamicore nameplate for each disconnect and separately enclosed breaker. Nameplates shall state source of circuit, load served, circuit number, voltage, and phase. Refer to Section 260563 - Identification for Electrical Systems.
- E. Provide disconnect switches for all motors, HVAC, plumbing equipment, and other electrically operated equipment where not connected by cord and plug. Disconnect switches shall be fused where equipment manufacturers electrical data label plate states "Maximum Fuse Size", or similar wording.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section describes separately mounted starters that are furnished under this Division.
- B. Certain starters and contactors are provided under other divisions, either separately mounted or integral with the equipment, and shall be installed and connected under Division 26

1.2 NAMEPLATES

A. Provide engraved "lamicore" nameplates for all separately mounted starters, indicating the equipment served. Refer also to Section 26 05 63 - Identification For Electrical Systems.

1.3 SUBMITTAL DOCUMENTS

- A. Required for all equipment specified by this section.
- B. Technical data and catalog sheets completely describing physical and electrical characteristics of all unit-mounted and individually mounted starters.
- 1.4 OPERATION AND MAINTENCE MANUALS
 - A. Provide record copy of all submittal documents and assemble as identified in another section.

1.5 COORDINATION WITH THE WORK OF OTHERS

A. Coordinate with each trade furnishing equipment requiring electrical service to verify and determine that the characteristics shown on the electrical drawings for the circuit serving the equipment are compatible with the requirements of the equipment being furnished. Provide written notice of any discrepancies.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Eaton/Cutler-Hammer
- B. ABB/General Electric
- C. Schneider/Square D

2.3 STARTERS

- A. NEMA sized, magnetic, full-voltage, non-reversing, single-speed (FVNR);
- B. Where specifically indicated on the drawings provide magnetic starters of other types, such as reversing or reduced-voltage
- C. With "hand-off-automatic" switch. Provide (2) SPDT additional contacts on switch for use by DDC Controls Vendor to monitor position of switch.
- D. With 120 volt control power transformer, with fused primary and grounded fused secondary.
- E. Red and green "LED" type pilot lights to indicate "RUN" or "OFF"
- F. With two additional spare single-pole double-throw (SPDT) contacts.
- G. With electronic solid-state type overloads sized on the basis of the actual full load running current of the motors furnished; overloads in all three phases.
- H. With reset button in cover
- I. Combination starters shall incorporate an adjustable, magnetic-only, motor circuit protector (MCP) type circuit breaker. MCP's with current limiters shall be provided where required by the available fault current. The MCP rating shall be selected on the basis of the horsepower of the actual motor installed.
- J. Provide combination undervoltage/anti-phase protection relay Time Mark Model 265, installed inside starter enclosure.
- K. Provide oversized starter enclosure where required to enable installation of the Time Mark device, specified above.
- L. Starter doors shall be interlocked to prevent opening of the door with disconnect in the "on" position, with approved voidable feature.
- M. Disconnect handle shall have padlocking provisions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Mount individual starters directly on wall, or on structure, or on auxiliary Unistrut framing where other suitable mounting surface is not available.

- B. For gypsum board wall mounting, group and mount starters on suitably painted, fire-retardant wood backboards.
- C. Provide engraved plastic nameplate for each starter with description of equipment served. Refer to Section 26 05 63 Identification for Electrical Systems.

3.2 OVERLOAD ELEMENTS

- A. Adjust and set solid-state overload elements based on actual motor nameplate data, motor ambient temperature, and starter ambient temperature, where different from motor.
- B. Provide a tabulation of all motors, indicating motor designation, nameplate full-load current, measurement of full load motor current draw, ambient temperatures, and overload type provided