# MIAMI UNIVERSITY

## SOUTHWEST OHIO REGIONAL DEPOSITORY

### HVAC Improvements

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PART 1 GENERAL

1.01 The Contractor responsible for scheduling the project, coordinating the Contractors, and providing other services identified in the contract documents shall be the Elevator Contractor.

1.02 Mechanical Contractor Scope of Work:

A. The Mechanical Contractor is the Single Prime Contractor for this project. All other contractors will be subcontractor to the Mechanical contractor.

B. All work to be done Summer 2019. Coordinate exact time frame with the University.

C. Contractor shall be responsible for all work on shown on the drawings and all the specifications in the manual.

D. Provide labor and materials necessary to complete the following items and appurtenances to make a complete system.

1. Remove existing boilers B-1 & B-2. Remove associated hot water storage tank, expansion tank, makeup water lines, air separator, and chemical shot feeder.

2. Remove existing constant volume heating water pumps.

3. Remove all piping associated with existing heating hot water boilers, pumps, and hot water storage tank.

4. Remove existing Trane DDC controls system. If the existing VAV box alternate does not get accepted then the control panel that serves the existing VAV boxes is existing to remain and the Trane front end shall remain operational.

5. Remove existing Trane temperature control panel on all ten air handling units.

5. Install new boilers B-2 & B-3. Install new expansion tank and sidestream chemical shot feeder, air separator and all valves shown on the piping schematics. The existing concrete pads shall be utilized and expanded as required to accommodate the new boilers.

6. Install new boiler primary pumps P-3 & P-4. Interlock associated pumps with the boiler controller. The boilers shall modulate the speed of the circulator pumps to maximize efficiency.

7. Install new secondary pumps P-1 & P-2. The new pumps shall be controlled by variable frequency drives and will modulate based on differential pressure. The new differential pressure sensor will be located in mechanical room 175.

8. Install new building automation system. The existing mechanical equipment in the building shall be integrated into the new building automation system.

9. Provide power to new HVAC equipment as shown on the electrical drawings.
E. Furnish all labor, materials, tools, incidentals and details necessary to provide a complete mechanical system, ready to operate, including but not limited to the items listed under the Mechanical Specification Indexes.

F. The Mechanical Contractor shall be responsible for fully coordinating the new work with the existing conditions and shall be responsible for the minor relocation of any existing piping that is required for installation of his equipment.

G. Include any minor details essential to successful operation and any other items specified or shown on the Drawings.

1.03 Electrical Sub-Contractor Scope of Work:

A. The Electrical Contractor will be a sub-contractor for this project.

B. Remove the existing electrical connections; disconnect switches, etc. associated with the chiller demolition as shown on the Drawings.

C. Provide all labor and materials necessary for the electrical installation of the Chiller, pumps, and appurtenances.

D. The Electrical Contractor shall work in conjunction with the Mechanical Contractor to ensure a complete installation of the new electrical system including new, final conduit locations, piping, etc.

E. Include any minor details essential to successful operation and any other items specified or shown on the Drawings.

F. Furnish all labor, materials, tools, incidentals and details necessary to provide the complete electrical connections, ready to operate, including but not limited to the items listed under the Electrical Specification Indexes.

PART 2 PRODUCTS

(Not Applicable).

PART 3 EXECUTION

(Not Applicable).

End of Section
PART 1 GENERAL

1.01 The Prime (Mechanical) Contractor is responsible for developing and coordinating a complete construction schedule including the separate sub-contractors. The schedule shall be fully coordinated including each contractor’s task, duration, etc. and shall include the milestone dates outlined in this section. It is important to note that the work is required to be performed during pre-determined times to minimize down time of the heating water system. The heating water system is the most critical component to this project. The controls portion of this project is less critical. The new heating water and control system shall be installed starting May 18th and will end on August 14th. See University Front End Division 0 for further requirements.

1.02 Electrical wiring, etc., needed to power new equipment shall be completed to enable equipment to be operational by the dates shown on the drawings.

PART 2 PRODUCTS

(Not Applicable)

PART 3 EXECUTION

(Not Applicable)

End of Section
## HVAC SPECIFICATIONS

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SECTION 23 01 05
HVAC GENERAL PROVISIONS

PART 1 GENERAL

1.01 REFERENCES

A. Divisions 23, cover Heating, Ventilating and Air Conditioning and HVAC control work specifically. The Heating, Ventilating and Air Conditioning Contractor shall conform to all provisions of these divisions and is to consider the word "Contractor" to mean themselves.

1.02 GENERAL REQUIREMENTS

A. Furnish all labor, materials, tools, incidentals and details necessary to provide a complete mechanical system, ready to operate, including but not limited to the items listed under the Mechanical Specification Indexes and as shown on the drawings. The scope shall include the following:

1. Remove existing boilers B-1 & B-2. Remove associated hot water storage tank, expansion tank, makeup water lines, and chemical shot feeder.

2. Remove all piping associated with existing heating hot water boilers, pumps, and hot water storage tank.

3. Remove existing Trane DDC controls system. Remove all components of the existing Trane system including control panels & front end computer.

4. Remove existing Trane temperature control panel on all ten air handling units.

5. Provide new temperature control panel on all ten air handling units.

6. Install new boilers B-2 & B-3. Install new expansion tank and sidestream chemical shot feeder, air separator and all valves shown on the piping schematics. The existing concrete pads shall be utilized and expanded as required to accommodate the new boilers.

7. Install new boiler primary pumps P-3 & P-4. Interlock pumps with associated boiler. The boilers shall modulate the speed of the circulator pumps to maximize efficiency and shall be controlled by the integral boiler control panel.

8. Install new building automation system. The existing mechanical equipment in the building shall be integrated into the new building automation system.

B. Include any minor details essential to successful operation and any other items specified or shown on the Drawings.

C. The Contractor is required to read the Specifications covering all branches of the work and will be held responsible for coordination of his work with work performed under all other Contracts.
D. The Contractor is required to visit the site and fully inform himself concerning all conditions affecting the scope of his work. Failure to visit the site shall not relieve the Contractor from any responsibility in the performance of his Contract.

E. The Contractor should feel free to contact the A/E immediately if there is any question regarding the meaning or intent of either Plans or Specifications, or if he notices any discrepancies or omissions in either Plans or Specifications.

F. Other than minor adjustments shall be submitted to the A/E for approval before proceeding with the work.

G. The Contractor shall submit on his letterhead, along with the Bid, the manufacturer's name and the names of all Subcontractors to whom he intends to sublet the work. If the Contractor fails to provide this information with the Bid, A/E shall have the right to select the manufacturers and Subcontractors with no additional charge.

H. Scheduling of all work performed by this Contractor shall be completely coordinated with the A/E.

I. This Contractor shall furnish to A/E a written description of procedure on this job including scheduling of the work to be done for his approval. This shall be submitted within 10 days after the Contract is awarded. There shall be six (6) copies.

J. All material hoisting by trade involved.

K. Arrangements for storage of tools and material, removal of debris, and interruptions of services shall be made with the A/E.

L. The Contractor, insofar as this Contract is concerned, shall at all times keep the premises and the building in a neat and orderly condition.

M. At the completion of the project, this Contractor shall promptly clean up and remove from the site, all debris and excess materials.

1.03 DRAWINGS

A. Consult all Contract Drawings which may affect the locations of any equipment, apparatus, piping and ductwork and make minor adjustments in location to secure coordination.

B. Piping and duct layout is schematic and exact locations shall be determined by structural and other conditions and verified in the field. This shall not be construed to mean that the design of the system may be changed, it refers only to the exact location of piping and ductwork to fit into the building as constructed, and to coordination of all work with piping and equipment included under other Divisions of the Specifications.

C. The layout shown on the Drawings is based on a particular make of equipment. If another make of equipment is used which requires modifications or changes of any description from the Drawings or Specifications, this Contractor shall be responsible for making all such modifications and changes, including those involving other trades, as a part of this Contract and the cost thereof shall be included in his Bid. In such case, the Contractor shall submit Drawings and Specifications showing all such modifications and changes prior to starting work, which shall be subject to the approval of the A/E.
D. The A/E reserves the right to make minor changes in the location of piping and equipment up to the time of rough-in without additional cost to the Owner.

E. Where certain grades and/or elevations are given on the Drawings, they have been obtained from the best information available; however, they are not guaranteed. This Contractor MUST assume the full responsibility of verifying present elevations in the field and making any adjustments as may be necessary, all of which must be included in his Bid Price.

F. Due to the scale of the Drawings, it is impossible to show all offsets and transitions which may be required. This Contractor shall carefully investigate the conditions affecting all work and shall furnish all elbows, fittings, transitions, etc., required to accomplish the desired result at no additional cost to the Owner.

G. Install all work as close as possible to walls, ceilings, struts, members, etc., consistent with the proper space for covering, access, etc., so as to occupy the minimum of space.

H. Actual dimensions shown on the Drawings and field dimensions shall take precedence over scaled dimensions.

1.04 PERMITS, INSPECTIONS AND CODES

A. The A/E shall obtain all necessary permits and pay for inspection fees. This contractor shall schedule inspections related to his work.

B. Completed installations shall conform with all applicable Federal, State and Local Laws, Codes and Ordinances, including but not limited to the latest editions of the following:

1. Ohio Building Code, Department of Industrial Relations, State of Ohio.


3. Specific Safety Requirements Covering the Installation of Pressure Piping Systems, Industrial Commission and Department of Industrial Relations, State of Ohio.

4. Ohio Pressure Piping Systems Rules, Ohio Board of Building Standards and Department of Industrial Relations, State of Ohio.

5. A.S.M.E. Pressure Piping Code - Section B31.1


10. Miami University Design Standards.
C. Nothing contained in the Plans and Specifications shall be construed to conflict with these laws, codes and ordinances and they are hereby made a part of these Specifications.

1.05 RECORD DOCUMENTS

A. The Contractor shall keep an accurate record of all deviations from Contract Drawings and Specifications. He shall neatly and correctly enter in colored pencil any deviations on Drawings affected and shall keep the Drawings available for inspection. Extra sets of Drawings will be furnished for this purpose.

B. At the completion of project and before final approval, make any final corrections to Drawings and certify to the accuracy of each print by signature and deliver same to the Owner.

1.06 SUPERVISION

A. This Contractor shall have in charge of the work, on the job during construction, a competent superintendent experienced in the work installed under this Contract.

1.07 UNACCEPTABLE WORK AND OBSERVATION REPORTS

A. Work shall be unacceptable when found to be defective or contrary to the Plans, Specifications, Codes specified or accepted standards of good workmanship.

B. The Contractor shall promptly correct all work found unacceptable by the A/E or Owner whether observed before or after substantial completion and whether or not fabricated, installed or completed. The Contractor shall bear all costs of correcting such unacceptable work, including compensation for the A/E's additional services made necessary thereby.

C. During the course of construction, the A/E will prepare "Observation Reports" with a list of items found to be in need of correction. All items listed shall be corrected by the Contractor. A space is provided on the form for the Contractor to note the completion of each item. All prior "Observation Report" items must be completed, the lists signed and returned to the A/E prior to making the final inspection. After the final list is issued, the same procedure will apply.

1.08 FINAL INSPECTION

A. When the Contractor determines all work is completed and working properly per the Contract Documents, he shall request a "final" inspection by the A/E in writing. If more than one reinspection is required after this final inspection, the Contractor shall bear all additional costs including compensation for the A/E's additional services made necessary thereby. A final inspection will not be made until Operating and Maintenance Manuals and Air Balance Reports are submitted and approved and all prior "Observation Report" punch lists completed, signed and returned to the A/E.

B. As part of the final checkout of the project, the A/E will be checking out the operation of the various systems. This Contractor shall provide such assistance as required (including manpower and tools) to start and stop the various systems, open and close valves etc. and simulate summer, winter and other temperature control sequences. The Contractor (not the A/E) is responsible to turn on the systems and demonstrate they are operating properly.
1.09 GUARANTEE

A. This Contractor is responsible for all defects, repairs and replacements in materials and workmanship, for a period of one (1) year after final payment is approved by the A/E.

PART 2 PRODUCTS

Not Applicable.

PART 3 EXECUTION

Not Applicable.

END OF SECTION 23 01 05
PART 1  GENERAL

1.01  SCOPE

A. The Contractor shall submit to the A/E for review, within two weeks after date of contract, one (1) electronic copy of manufacturer's drawings and data. The A/E will review Contractor's shop drawings and related submittals (as indicated below) with respect to the ability of the detailed work, when complete, to be a properly functioning integral element of the overall system designed by the A/E. Before submitting a shop drawing or any related material to the A/E, Contractor shall: review each such submission for conformance with the means, methods, techniques, sequences, and operations of construction, and safety precautions and programs incidental thereto, all of which are the sole responsibility of Contractor; approve each such submission before submitting it; and so stamp each such submission before submitting it. The A/E shall assume that no shop drawing or related submittal comprises a variation unless Contractor advises A/E otherwise via a written instrument which is acknowledged by A/E in writing. The shop drawings and related material (if any) called for are indicated below:

Heating, Ventilating and Air Conditioning Contract

Heating Water Boilers
Heating Water Piping
Valves and Piping Specialties
Pipe Insulation
Pumps and Curves
Temperature Controls
Chemical treatment system

B. The A/E shall return shop drawings and related materials with comments provided that each submission has been called for and is stamped by Contractor as indicated above. The A/E shall return without comment material not called for or which has not been approved by Contractor.

C. The A/E's review of manufacturer's drawings or schedules shall not relieve the Contractor from compliance with the requirements of the plans and specifications.

1.02  QUANTITIES

A. Items may be referred to in singular or plural on Plans and Specifications. Contractor is responsible for determining quantity of each item.

PART 2  PRODUCTS

Not Applicable

PART 3  EXECUTION

Not Applicable

END OF SECTION 23 01 10
SECTION 23 05 13

ELECTRICAL WORK

PART 1 GENERAL

1.01 REFERENCE
   A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.

1.02 SCOPE
   A. The HVAC contractor shall furnish all motors for his equipment. Motor starters, safety switches and wired junction boxes shall be furnished and installed by the Electrical contractor except where specifically specified to be furnished with certain mechanical equipment.

1.03 WORK INCLUDED – HVAC Contractor:
   A. Temperature Control wiring by (Temperature Control) Contractor except as noted below by (Electrical) contractor.
   B. 120 volt wiring required for mechanical equipment when not shown or specified elsewhere.

1.05 WORK INCLUDED – Electrical Sub-Contractor.
   A. All power wiring.
   B. All conduit and wiring incidental to Temperature Controls, including switches, controls, transformers and relays shall be by the Temperature Control Sub-Contractor, except wiring as indicated on the Electrical Drawings will be by the Electrical Sub-Contractor.
   C. Motor starters, contactors, and disconnects where noted under "PRODUCTS" below.
   D. Electrical Sub-Contractor shall provide 120 volt control power to a wired junction box near the Temperature Control Cabinets. Final connections to be made by the Temperature Control Sub-Contractor.

1.06 SHOP DRAWINGS:
   A. The Temperature Control Sub-Contractor shall furnish to the Electrical Sub-Contractor, equipment shop drawings which will indicate power hook-up and control connections as required for mechanical equipment. "Stock" Wiring Diagrams are Not Acceptable.
   B. Prepare, as a part of Temperature Control shop drawings, complete terminal-to-terminal wiring diagrams. These will show terminal designations on control items and equipment. Wiring diagrams to be compatible with Electrical Drawings.

PART 2 PRODUCTS
2.01 Refer to Section 23 01 05 - Paragraph 1.05 for "Energy Code" requirements (Particularly power factor correction)

2.02 Refer to Division 16 - ELECTRICAL.

2.03 MOTORS

A. Shall be furnished with all motor driven equipment.
B. Motor speed shall not exceed 1750 RPM unless higher speed is required to perform duty.
C. Required break horsepower shall not exceed 90 percent of the nameplate horsepower for direct driven equipment or 85 percent of nameplate horsepower for belt driven equipment.
D. Shall be externally lubricated, open drip proof and conform to NEMA construction standard with Class B insulation for 49 degrees C. ambient.
E. Motors exposed to weather or located in wet locations shall be totally enclosed fan cooled type.
F. Motors shall have a 1.15 service factor.
G. All motors shall be premium efficiency.
H. Power factor shall be 90 percent or better.
I. Manufacturers: Gould, General Electric, or Westinghouse
J. All motors 1/2 HP and larger shall be three phase; all motors, 1/3 HP and smaller shall be single phase unless specified otherwise.
K. All motors furnished shall have copper windings and all motors five (5) horsepower and greater shall have factory installed lifting eyebolts. All motors shall conform to ANSI and NEMA standards.
L. All motors used in variable speed applications shall be premium efficiency type and shall be rated for use with variable frequency drives with AEGIS shaft grounding to protect the motor bearings from stray currents.

2.06 Motor starters, contactors, and disconnects are provided and installed by the Electrical Sub-Contractor, unless part of packaged equipment furnished by the HVAC Contractor, or otherwise specified.

PART 3 EXECUTION

3.01 All wiring, conduits, etc., shall be in strict accordance with the requirements of the latest edition of the National Electrical Code and Division 26, Electrical specification.

3.02 All wiring, including low voltage wiring, shall be run in conduit.

3.03 Low voltage wiring may be size and type recommended by the Manufacturer and/or Temperature Control Sub-Contractor.

END OF SECTION 23 05 13
PART 1 – GENERAL

1.01 REFERENCE
   A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.

1.02 SCOPE
   A. The HVAC Contractor shall be responsible for firestopping around all openings for pipes, ducts, conduits, etc., installed by him at all fire walls and smoke walls. Firestopping shall be performed by an installer who has been trained by manufacturer, or manufacturer's representative, in the installation procedures based on published UL tested fire stop systems.

1.03 DEFINITIONS
   A. Firestopping: Material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies.

1.04 GENERAL REQUIREMENTS

   B. Underwriters Laboratories (UL) of Northbrook, IL runs ASTM E-814 under their designation of UL 1479 and publishes the results in their "FIRE RESISTANCE DIRECTORY" that is updated annually.

   1. UL Fire Resistance Directory:
      a. Through-Penetration Firestop Devices (XHCR)
      b. Fire Resistance Ratings (BXUV)
      c. Through-Penetration Firestop Systems (XHEZ)
      d. Fill, Voids, or Cavity Material (XHHW)
      e. Forming Materials (XHKU)

   C. International Firestop Council Guidelines for Evaluating Firestop Systems Contractor Judgments


   E. The Ohio Building Code (OBC)


1.05 QUALITY ASSURANCE
A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate HVAC Contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.

B. Firestop System installation must meet requirements of ASTM E-814 or UL 1479 tested assemblies that provide a fire rating equal to that of construction being penetrated.

C. Proposed firestop materials and methods shall conform to applicable governing codes having local jurisdiction.

D. Firestop Systems do not reestablish the structural integrity of load bearing partitions/assemblies, or support live loads and traffic. Installer shall consult the structural Construction Manager prior to penetrating any load bearing assembly.

E. For those firestop applications that exist for which no UL tested system is available through a manufacturer, a manufacturer's Contractor judgment derived from similar UL system designs or other tests will be submitted to local authorities having jurisdiction for their review and approval prior to installation. Contractor judgment drawings must follow requirements set forth by the International Firestop Council (September 7, 1994).

1.06 SUBMITTALS

A. Submit Product Data: Manufacturer’s specifications and technical data for each material including the composition and limitations, documentation of UL firestop systems to be used and manufacturer’s installation instructions.

B. Manufacturer's Contractor judgment identification number and drawing details when no UL system is available for an application. Construction Manager judgment must include both project name and HVAC Contractor’s name who will install firestop system as described in drawing.

C. Submit material safety data sheets provided with product delivered to job-site.

1.07 INSTALLER QUALIFICATIONS

A. Engage an experienced Installer who is certified, licensed, or otherwise qualified by the firestopping manufacturer as having been provided the necessary training to install manufacturer’s products per specified requirements. A manufacturer’s willingness to sell its firestopping products to the HVAC Contractor or to an Installer engaged by the HVAC Contractor does not in itself confer qualification on the buyer.

1.08 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials undamaged in manufacturer’s clearly labeled, unopened containers, identified with brand, type, and UL label where applicable.

B. Coordinate delivery of materials with scheduled installation date to allow minimum storage time at job-site.

C. Store materials under cover and protect from weather and damage in compliance with manufacturer’s requirements.

D. Comply with recommended procedures, precautions or remedies described in material safety data sheets as applicable.
1.09 PROJECT CONDITIONS

A. Do not use materials that contain flammable solvents.

B. Scheduling

1. Schedule installation of CAST IN PLACE firestop devices after completion of floor formwork, metal form deck, or composite deck but before placement of concrete.

2. Schedule installation of other firestopping materials after completion of penetrating item installation but prior to covering or concealing of openings.

C. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

D. Weather conditions: Do not proceed with installation of firestop materials when temperatures exceed the manufacturer’s recommended limitations for installation printed on product label and product data sheet.

E. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating any adjacent surfaces.

PART 2 – PRODUCTS

2.01 FIRESTOPPING, GENERAL

A. Provide firestopping composed of components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating the firestopping under conditions of service and application, as demonstrated by the firestopping manufacturer based on testing and field experience.

B. Provide components for each firestopping system that is needed to install fill material. Use only components specified by the firestopping manufacturer and approved by the qualified testing agency for the designated fire-resistance-rated systems.

2.02 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with through penetration firestop systems (XHEZ) listed in Volume II of the UL Fire Resistance Directory, provide products of the following manufacturers as identified below:

1. Hilti, Inc., Tulsa, Oklahoma, (800)879-8000
2. Tremco Sealants & Coatings, Beachwood, Ohio, (216) 292-5000
3. 3M Fire Protection Products, St. Paul, Minnesota, (612) 736-0203

2.03 MATERIALS

A. Use only firestop products that have been UL 1479, ASTM E-814 tested for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire-rating involved for each separate instance.
B. Cast-in place firestop devices are installed prior to concrete placement for use with non-combustible and combustible plastic pipe (closed and open piping systems) penetrating concrete floors, the following products are acceptable:

1. Hilti CP 680 Cast-In Place Firestop Device
2. Fox Coupling, Inc. "Cast-In-Place Firestop Coupling".
3. Proset Cast-In-Place Device

C. Sealant or caulking materials for use with non-combustible items including steel pipe & copper pipe, the following products are acceptable:

1. Hilti FS-ONE Intumescent Firestop Sealant
2. 3M Fire Barrier CP25 or Firestop Sealant 2000
3. Tremco Fyre Shield

D. Sealant or caulking materials for use with sheet metal ducts, the following products are acceptable:

1. Hilti CP 601S Elastomeric Firestop Sealant or CP 606 Flexible Firestop Sealant
2. Tremco Fyre-Shield High Performance Ceramic Firestop Sealant
3. 3M Fire Barrier CP25WB+ or 2000 Silicone Sealant

E. Intumescent sealant or caulking materials for use with combustible items (penetrants consumed by high heat and flame) including insulated metal pipe and plastic pipe, the following products are acceptable:

1. Hilti FS-ONE Intumescent Firestop Sealant
2. 3M Fire Barrier CP25WB+
3. Tremco Intumescent Acrylic or TremStop WBM

F. Firestop collar or wrap devices attached to assembly around combustible plastic pipe (closed and open piping systems), the following products are acceptable:

1. Hilti CP 642 and CP643 Firestop Collar, CP645 Wrap Strip
2. Tremco TREMstop D Combustible Pipe Intumescent Device System and TremStop WS Wrap Strip
3. 3M Ultra Plastic Pipe Device and Fire Barrier FS-195+ Wrap Strip

G. Materials used for large size/complex penetrations made to accommodate multiple steel and copper pipes, the following products are acceptable:

1. Hilti FS 635 Trowelable Firestop Compound and FS 657 FIRE BLOCK
2. Tremco TremStop M Fire Rated Mortar and PS Pillows
3. 3M Fire Barrier CS-195+ Composite Sheet

H. Non curing, re-penetrable materials used for large size/complex penetrations made to accommodate multiple steel and copper pipes, the following products are acceptable:

1. Hilti FS 657 FIRE BLOCK
2. Tremco PS Firestop Pillows
3. 3M CS Intumescent Sheet

I. Provide a firestop system with an "F" Rating as determined by UL 1479 or ASTM E814. The F rating must be a minimum of one (1) hour but not less than the fire resistance rating of the assembly being penetrated.
PART 3 – EXECUTION

3.01 PREPARATION

A. Verification of Conditions: Examine areas and conditions under which work is to be performed and identify conditions detrimental to proper or timely completion.

1. Verify penetrations are properly sized and in suitable condition for application of materials.

2. Surfaces to which firestop materials will be applied shall be free of dirt, grease, oil, rust, laitance, release agents, water repellents, and any other substances that may affect proper adhesion.

3. Provide masking and temporary covering to prevent soiling of adjacent surfaces by firestopping materials.

4. Comply with manufacturer's recommendations for temperature and humidity conditions before, during and after installation of firestopping.

5. Do not proceed until unsatisfactory conditions have been corrected.

3.02 COORDINATION

A. Coordinate location and proper selection of cast-in-place Firestop Devices with trade responsible for the work. Ensure device is installed before placement of concrete.

B. Responsible trade to provide adequate spacing of field run pipes to allow for installation of cast-in-place firestop devices without interferences.

3.03 INSTALLATION


B. Manufacturer's Instructions: Comply with manufacturer's instructions for installation of through-penetration joint materials.

1. Seal all holes or voids made by penetrations to ensure an air and water resistant seal.

2. Consult with mechanical Contractor and damper manufacturer prior to installation of UL firestop systems that might hamper the performance of fire dampers as it pertains to duct work.

3. Protect materials from damage on surfaces subjected to traffic.

3.04 FIELD QUALITY CONTROL

A. Examine sealed penetration areas to ensure proper installation before concealing or enclosing areas. All penetrations are to be labeled in accordance with the Contractor's standard labeling system. The HVAC Contractor shall coordinate all fire stopping requirements prior to start of work.
B. Keep areas of work accessible until inspection and approval have been completed.

C. All fire stopping shall be inspected and approved by a licensed independent Consultant. All unapproved fire stopping products installed by the HVAC Contractor will be removed and replaced at his expense.

D. Perform under this section patching and repairing of firestopping caused by cutting or penetrating of existing firestop systems already installed by other trades.

3.05 ADJUSTING AND CLEANING

A. Remove equipment, materials and debris, leaving area in undamaged, clean condition.

B. Clean all surfaces adjacent to sealed holes and joints to be free of excess firestop materials and soiling as work progresses.

END OF SECTION 23 05 17
PART 1 GENERAL

1.01 SCOPE

A. Furnish and install all necessary piping specialties to include thermometers, gauges, pipe strainers, etc., for piping systems included under this Contract.

PART 2 PRODUCTS

2.01 Thermometers - Trerice B85604 - Bi-Metal, Dial Type with 5" stainless steel case, adjustable joint with locking device. Provide brass separable socket. Ashcroft, Marsh, or Weiss of the same type may be furnished at the Contractor's option. Ranges as shown on the Drawings.

2.02 Combination Altitude/Pressure Gauges - Altitude/Pressure gauges shall be 4-1/2" dial bourdon spring type with black case, recalibration in dial face, scales in feet of head and pounds per square inch range 50 percent above normal working pressure. As manufactured by Trerice, Ashcroft, Marsh. Furnish a pulsation snubber for each gauge.

2.03 Air Vents

A. Air vents shall be as manufactured by Bell and Gossett, TACO, Trane, Thrush, Dunham Bush or Hoffman. Install at high points of system on each heating and cooling coil and at other locations subject to air binding.

1. Manual air vents shall be ball valves piped as detailed on the drawings. For use on individual heating elements.

2. Manual air vent for cabinet unit heater cabinets shall be all brass cock, 1/8" pipe tap, Powell 914.

3. Large capacity for use on central coils and for venting mains shall have a cast iron body and bonnet with stainless steel, brass and EPDM internal components. Vent shall be suitable for a maximum operating temperature of 250 degrees F and a maximum operating pressure of 150 psi. Vents shall have 3/4" NPT inlet and 3/8" NPT outlet. Equal to Bell & Gossett model No. 107A. Provide ball valve for each vent. Pipe outlet to nearest drain point with 1/8" inside diameter copper tube.

2.04 Strainers

A. All water lines – Splirax/Sarco style IF-125 (flanged) or IT (threaded) 125 psig, Y-pattern, cast iron body with stainless steel screen for water. Threaded for 2-1/2" and smaller, flanged for 3" and larger.

B. Duplex basket strainers – Mueller 792 SB, Class 125, 200 PSIG, Bronze, Dual basket strainer with ball isolation/switch over valve, 30 mesh stainless steel strainer.

C. Dunham-Bush, Spirax/Sarco, Armstrong, Trane, McAlear, Mueller, Metraflex, Wheatley or V. D. Anderson strainers may be furnished at the contractor's option.
2.05 Pete's Plug

A. 1/4" MPT fitting to receive either a temperature or pressure probe, 1/8" O.D. fitting and caps shall be brass with valve core of Nordel, rated at 1000 psig.

B. Provide XL (extra long) type Pete's plug in insulated lines.

C. Sisco plugs may be furnished at the Contractor's option.

2.06 Flexible Vibration Joints shall be selected from the following types, subject to the limitations listed:

A. Type 1 - Corrugated copper or stainless steel bellows connectors shall be constructed with a woven flexible bronze wire reinforcing protective jacket (4" and larger may be galvanized steel braid) constructed for not less than 125 lb. working pressure. Connectors shall be of sufficient length to allow for 1/2" misalignment of piping and shall have flanged ends except 2" and smaller may be screwed. Connectors shall be Metraflex, Flexconics Corp., Anaconda, Vibration Mountings Inc.

B. Type 2 - Reinforced Teflon molded bellows connectors shall have drilled ductile iron flanges, metal reinforcing rings and limit rods with isolating grommets and shall be of sufficient length and number of bellow to allow for 1/2" lateral misalignment of piping and constructed for not less than 125 pound working pressure. These connectors shall be Metraflex, Vibration Mountings Inc., Use of this type of connection shall be subject to the temperature pressure limitation and shall be governed by manufacturers published data and recommendations.

C. Furnish with full faced flanges with matching welding type companion flanges. Connections to be bolted.

2.07 Suction Diffuser – Bell and Gossett Type “Z”, angle pattern flow straightening fitting equipped with a combination diffuser-strainer-orifice cylinder, flow straightening vanes, start-up strainer, permanent magnet and adjustable support foot. The combination diffuser-strainer-orifice cylinder shall be designed to withstand pressure differential equal to the system pump shutoff head (maximum 0.3 PSIG) and shall have a free area equal to five times the cross section area of the pump suction opening. The length of the flow straightening vanes shall be no less than 2 times the diameter of the system pump suction connection.

The flow straightening fitting shall be of cast iron construction with pump connection sizes as noted. The fitting shall have a stainless steel combination diffuser-strainer-orifice cylinder with 3/16" diameter perforations to protect the system pump. The full length stainless steel flow straightening vanes shall provide nonturbulent flow to the suction side of the system pump. The magnet shall be positioned in the flow stream to protect the pump seal(s). The start-up strainer shall be of 16 mesh bronze, and the adjustable support foot shall eliminate pipe strain at the flow fitting/pump connection. All internal components shall be replaceable. Provide stainless steel mesh strainer element in condenser water system suction diffusers.

PART 3 EXECUTION

3.01 All specialties to be installed in accordance with manufacturer's recommendations.

3.02 Flexible vibration joints to be installed within tolerances specified by manufacturer.

END OF SECTION 23 05 19
PART 1 GENERAL

1.01 REFERENCE
   A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.
   
1.02 SCOPE
   A. All unpainted steel in exposed areas (not including Mechanical Rooms) including piping, hangers, ironwork, etc., shall be painted with one (1) coat of primer and one (1) coat enamel paint.
   
   B. All steel supports shall have minimum one (1) coat of metal primer after fabrication.
   
   C. Factory finished equipment which has rusted or been damaged shall be cleaned at the completion of the project and rust spots and marred areas shall be refinished and restored to the original factory finish.

PART 2 PRODUCTS

2.01 Paint shall be Miami University standard.

PART 3 EXECUTION

Not Applicable

END OF SECTION 23 05 20
PART 1 GENERAL

Not Applicable

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.01 Cutting for openings, when necessary, shall be done by this Contractor with such tools and methods as to prevent unnecessary damage to surrounding areas or equipment.

3.02 The corners of all openings in poured concrete shall be core drilled to minimize overcutting.

3.03 Fill space in all areas where core drilled with packing where required to maintain fire rating. Openings shall be temporarily fire-stopped until permanent fire stopping is done. This includes holes left due to removal of piping or ductwork.

3.04 All holes cut for the installation of piping, ductwork and equipment shall be neatly patched and refinished with the same materials as, and to match, adjacent surfaces, and damages thereto shall be repaired in kind and to match existing conditions by this Contractor.

3.05 Patching shall match existing surfaces in kind and finish.

3.06 No structural member will be cut into without the expressed permission of the A/E and structural engineer.

END OF SECTION 23 05 21
PART 1  GENERAL

1.01  SCOPE

A. All concrete foundations and bases for mechanical equipment will be by the HVAC Contractor.
B. This Contractor shall furnish welded steel frames and supports for all equipment requiring same. Furnish auxiliary steel as required for supporting pipes.
C. The HVAC Contractor shall provide concrete foundations for all exterior HVAC pipe supports.

PART 2  PRODUCTS

2.01 All steel for frames and supports shall be standard weight black or galvanized steel pipe or standard structural steel shapes.
2.02 All exterior frames and supports shall be galvanized.
2.03 Concrete for pads shall be a minimum of 6 bag mix per cubic yard with maximum slump of 4” and shall be air entrained 5 to 7% by volume.

PART 3  EXECUTION

3.01 Grind all sharp corners and projections on supporting steel after fabrication. All steel shall have one (1) coat of metal primer after fabrication. All steel supports exposed to the weather shall be hot dip galvanized.

END OF SECTION 23 05 22
PART 1 GENERAL

1.01 REFERENCE

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.

1.02 SCOPE

A. Furnish and install all necessary valves for piping systems and equipment in the building required to provide proper shut off and balancing of systems included under this Contract.

PART 2 PRODUCTS

2.01 Check valves shall be Crane, Milwaukee, or Watts and shall all be by the same manufacturer.

2.02 Ball valves shall be as manufactured by Grinnell, Milwaukee, Watts, or any of the manufacturer’s listed herein for gate, globe and check valves. All ball valves to be by the same manufacturer.

2.03 Butterfly valves shall be as manufactured by Keystone, Worcester, Watts, Grinnell, Jamesbury, or any of the manufacturer’s listed herein for gate, globe and check valves. All butterfly valves to be by the same manufacturer.

2.04 Ball Valves

A. 3” size and smaller may be two-piece bronze body ball valve, screwed piping connections, union connection body, teflon seats, full port, blowout proof stem, adjustable packing gland, stainless steel ball, and lever handle labeled for service controlled. Rated for 150 S.W.P. and 400 WOG. Equal to Milwaukee 70-300 Series.

B. All ball valves shall be full port type.

2.05 BUTTERFLY VALVES

A. 4” and larger shall be cast or ductile iron valve. Furnish with lug pattern body, aluminum bronze disc, stainless steel stem, EPDM seat, extended neck for full 2” insulation, and positive shut off at 175 psig W.O.G. (2-12”) and 150 psi W.O.G. (14”-20”). Equal to Keystone Fig. AR-2.

B. 5” and smaller shall have minimum 10 position lever actuators, with positive latching and position indicator. Valves 6” and larger shall have worm gear actuator. Valves shown with chain to be chain operated.

C. Valves used on outlets of devices for balance purposes shall have an adjustable memory stop (position lock). A notched operator by itself is not considered a memory stop.

2.06 Drain valves shall be ball valves as specified above with hose nipple and cap.
2.07 Check Valves

A. 3" and larger - iron body, bronze mounted, horizontal swing check with bronze disc, flanged, 125 lb. S.W.P.

B. 2-1/2" and smaller - all bronze, horizontal swing check with bronze or TFE disc, screwed, 125 lb. S.W.P.

C. Clow, McAlear, Mueller or Metraflex non-slam check valves are acceptable manufacturers as well as previously listed manufacturers.

2.08 Combination Balance and Stop Valve - Bell and Gossett "Circuit Setter Plus", bronze body, screwed combination balance and stop ball valve. 2½" and smaller screwed. 3" and larger flanged. Valves to have readout ports, 1/4" drain port, memory stop indicator, calibrated nameplate, 300 lb. W.O.G. Valves shall be designed for a pressure drop of 2 to 5 feet heat. Same type Illinois, Spirax Sarco, Flow Design, Taco or Tour & Anderson stop and balance valves may be furnished at the Contractor's option.

PART 3 EXECUTION

3.01 The HVAC Contractor shall install all valves in strict accordance to the manufacturer's recommendations.

3.02 Where the Drawings call for both a shut-off valve and a balance valve or fitting, the HVAC Contractor may, at his option, furnish a combination balance and stop valve.

3.03 Where drain lines are not piped to floor drains, furnish hose end adapters. Provide caps for all hose end adapters.

3.04 Ball valves and butterfly valves designated with an “M” shall be furnished with memory stops.

3.05 The HVAC Contractor shall remove the start-up strainer from suction diffusers after pumps are operational and system has been chemically treated.

END OF SECTION 23 05 23
SECTION 23 05 29

INSERTS, PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 REFERENCE

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.

1.02 SCOPE

A. Furnish and install all necessary inserts, beam clamps and auxiliary steel for pipe hangers in the building.

B. Furnish and install necessary pipe hangers and supports to properly support all piping and to maintain uniform elevation.

PART 2 PRODUCTS

2.01 HANGERS

A. Hangers for copper lines, 2" and smaller, shall be similar to Grinnell Fig. CT-99, adjustable carbon steel pipe ring, with 3/8" hanger rods. All copper plated.

B. When copper lines are insulated and hangers are sized for outside of insulation, provide steel hangers as described below.

C. Hangers for steel lines 2" and smaller shall be similar to Grinnell Fig. 97, adjustable pipe ring, galvanized steel band with 3/8" hanger rods.

D. Hangers for steel lines 2-1/2" and larger shall be similar to Grinnell Fig. 260, adjustable carbon steel clevis, heavy duty, with proper size rods.

E. Hangers for chilled water lines shall be sized for outer diameter of insulation. Furnish pipe covering protection saddles for high pressure steam lines similar to Grinnell 160 Figures. Furnish 1/2 round galvanized sheet metal insulation protectors minimum 12" long similar to Grinnell Fig. 167 on bottom half of insulation for chilled water lines 1-1/4" and larger at each pipe hanger.

2.02 Support pipe and ductwork from the building structure from concrete inserts cast in place, "after set" all steel expansion shields, or by means of beam clamps with retaining clips attached to structural steel. Attachment to metal roof deck or ceiling support systems will not be acceptable. Provide auxiliary support steel to span between building structural members as required.

2.03 Where numerous pipes are run parallel to one another, the use of continuous slotted inserts is encouraged. Unistrut, Powerstrut, Elcen Kindorf or equivalent. Verify the depth of reinforcing before ordering this type of insert.
2.04 Trapeze type supports will be allowed for numerous pipes paralleling on another, however all services having changes in temperature shall be supported on rollers, for expansion. Other services shall be fitted with adequate guide to maintain the alignment of piping.

2.05 Power actuated anchoring devices will not be permitted without prior approval for anchoring nor other use at floors, columns, beams, precast concrete, etc. where so using causes cracking, spalling or other deformation to these members. In no case will such anchors be permitted less than 4" from any corner or change in direction of concrete surface to which anchor is attached.

2.06 Pipe hangers and supports by Elcen, Fee and Mason, Grinnell or Crane of the same type may be furnished at the Contractor's option.

PART 3 EXECUTION

3.01 Riser clamps shall be used at each floor where required.

3.02 Wall bracket pipe supports shall be installed where required.

3.03 All copper piping is to be shielded from steel pipes or electrical conduit with sheet lead or electrical tape wherever pipes would touch each other.

3.04 Galvanized hangers and strap hangers will not be permitted for supporting copper lines except for hangers sized for outside of insulation.

3.05 Provide pipe anchors and guides where and as indicated on the Drawings and elsewhere as required to properly control pipe. Method to suit job conditions.

3.06 Support piping at pumps and equipment from floor, ceiling, or walls, so that piping weight is not supported directly from pumps or equipment.

3.07 All beam clamps and supports for piping and ductwork shall be in place prior to the fireproofing of the structural steel.

3.08 Piping to be supported according to the following schedule. Support at intervals not to exceed spacing listed or elsewhere as required in accordance with good workmanship. No pipe shall be supported from another pipe. All hangers shall be plumbed before insulation is applied and all hangers shall be double nutted.

<table>
<thead>
<tr>
<th>(1) Steel Pipe</th>
<th>SPACING</th>
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<tbody>
<tr>
<td>Pipe Size</td>
<td>Rod</td>
</tr>
<tr>
<td>Thru 1&quot;</td>
<td>3/8&quot;</td>
</tr>
<tr>
<td>1-1/4&quot;</td>
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END OF SECTION 23 05 29
SECTION 23 05 30
INSTALLATION OF PIPING

PART 1 GENERAL

1.01 REFERENCE

A. Section 23 05 19 - PIPING SPECIALTIES
B. Section 23 05 23 - VALVES
C. Section 23 05 29 - INSERTS, PIPE HANGERS AND SUPPORTS
D. Section 23 05 93 - TESTS AND ADJUSTMENTS

1.02 SCOPE

A. The requirements of this Section shall apply to all interior piping systems installed under this Contract, except where otherwise noted on the Drawings or elsewhere in the Specifications.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.01 All piping systems shall be installed with adequate provisions made for expansion and contraction to prevent stresses on piping, valves and equipment. Anchor and guide piping at all points indicated and/or as required. Type and method of anchoring, guiding and attachments to sustaining members to suit job requirements and conditions and shall be approved by the A/E.

3.02 Provide flanges or unions at each screwed valve, final connection, and at each piece of equipment. Branches from mains to equipment stubs, risers, etc., to have swing joints with at least one change of direction in the horizontal plane, and one change of direction in the vertical plane, before connecting to equipment or fixtures. Piping shall be arranged and unions and flanges located to permit easy removal of valves, parts, and equipment for inspection and cleaning without disconnecting any part except unions or flanges. No welded connections shall be made to valves or equipment. Use bronze unions in copper lines. Unions to be downstream of valves.

3.03 Flange bolts shall be cut to proper length so that one thread projects beyond the nut when nut and bolt are tightened.

3.04 Make proper connections to all items of equipment in the Contract as recommended by the Manufacturer or as detailed on the Drawings.

3.05 All piping shall be arranged in accordance with the best standards of the trade with vertical pipes plumb and horizontal runs parallel or perpendicular to the building wall.

3.06 Provide valves and specialties where indicated on the Drawings.

3.07 Provide 3/4" drain valves in piping at low points to provide complete drainage of all systems and as shown on the Drawings.
3.08 Ream ends of pipe and clean before installing.

3.09 All joints in copper piping shall be made with 95-5 solder. Solders and fluxes containing lead are prohibited.

3.10 Use pipe dope on male threads of screwed pipe only. Teflon pipe joint tape may be used, at the Contractor's option.

3.11 Valves to be installed with handwheel at or above center of pipe. Valves outdoors exposed to weather shall be installed with handwheel in the horizontal.

3.12 Make all changes of direction with fittings, rather than bending.

3.13 All valves and unions to be installed so as to be accessible through ceiling, access panels, etc.

3.14 Provide dielectric unions or insulating flanges between dissimilar metals, i.e., copper to steel.

3.15 Bull head connections in any piping service are expressly prohibited.

3.16 At the end of each day’s work and otherwise as required or directed, provide caps and/or plugs at all openings in piping for protection. Particular attention must be given to avoid the possibility of any foreign materials entering the pipes, whether it be inadvertent or with malicious intent.

3.17 Flanged joints shall be faced true and square. Flanges shall be same face style as mating surface to which it is connected.

3.18 Install thermometers and gauges so they may be read from floor level.

3.19 Install Pete’s Plugs as close as possible to control valves, coils, etc., as shown on the Drawings, and arranged so that a probe may be inserted into the plug.

3.20 Where piping is installed in accessible chases, keep all piping to sides of chase, except portions which must necessarily be in center of chase. Offset vents to side immediately above connection to waste line. All lateral runs are to be located at the floor or minimum 6'-0" above floor, and all vertical piping held close to the wall through that height leaving maximum service space.

3.21 Where pipe drops occur in block walls, pipes to enter and leave walls at block joints.

3.22 Install galvanized sheet metal troughs with drains under pipes crossing electrical or telecommunications equipment. Seal to make water tight.

3.23 Do not run water piping through electrical rooms.

3.24 Properly support all relief valve discharge piping and provide no more than one 90° ell.

END OF SECTION 23 05 30
PART 1 GENERAL
1.01 REFERENCE
   A. Drawings and general provisions of the Contract, including General and Supplementary
      conditions and Divisions 01 Specifications Sections, apply to this Section.

1.02 SCOPE
   A. Furnish and install pipe markings, equipment labels and valve tags as described below.
   B. All labeling shall be in accordance with Miami University labeling and tagging standards.

PART 2 PRODUCTS
2.01 MATERIALS
   A. Snap around pipe markers.
   B. Tags shall be non-ferrous metal with number and service abbreviation engraved in the tag.

PART 3 EXECUTION
3.01 EQUIPMENT
   A. Each pump shall be labeled by means of 2” high stenciled, painted lettering, and by a
      permanent metal tag fastened to the unit. The stamped marking shall be permanent on
      the metal tag.
   B. Labeling shall consist of the unit designation as shown on the drawings and in addition,
      labeling of exhaust fans shall indicate the rooms or areas being served. Room numbers
      shall be from the Miami University numbering system, not those indicated on the
      drawings.
   C. Insure that nameplates are provided in readable locations. If they are not, they shall be
      removed and replaced in a visible location.

3.02 PIPE MARKINGS
   A. Markings shall be applied to all new piping after installation, insulation and final painting.
      Markings shall consist of 1” high black letters, a color coded band and a direction arrow.
      Markers shall be placed at 25 foot centers on both exposed and concealed piping.
      Painting letters by use of stencils is acceptable. Color code as follows:

      | Item                  | Color Bands  | Abbr.  |
      |-----------------------|--------------|--------|
      | Hot Water Heating Supply | Yellow-Red   | HWHS   |
      | Hot Water Heating Return | Yellow-Orange| HWHR   |
      | Drain                 | Aluminum     | D      |
      | Make-up Water Piping  | Black        | MW     |
3.03 VALVE TAGS

A. Each valve, including those installed adjacent to equipment for isolation of that item, shall be identified with a stamped aluminum or brass tag attached with a brass “S” hook or flexible metal wire. A printed schedule shall be prepared and framed under clear plastic or glass describing each valve by consecutive number, location and service for which used. On renovation work, begin new numbering with the last number used in the existing sequence. Two additional unframed copies shall be furnished, all being turned over to the A/E with a letter of transmittal. Copies shall also be included in the Owner’s Maintenance manual.

END OF SECTION 23 05 53
SECTION 23 05 93
TESTS AND ADJUSTMENTS

PART 1 GENERAL

1.01 REFERENCE
Not Applicable

1.02 SCOPE
A. After work has been completed but before pipe covering has been applied, the Contractor shall test and adjust the systems he has installed.

B. The A/E shall be notified of all scheduled tests and adjustments at least 48 hours before they are scheduled so that he may witness same. If the Contractor performs any test or adjustment without the A/E present or without properly notifying the A/E, the Contractor will be required to perform the test or adjustment a second time in the presence of the A/E.

C. If the A/E determines that any work requires special inspection, testing, or approval, he will, upon written authorization from the Owner, instruct the Contractor to order such special inspection, testing or approval. The Contractor shall give timely notice so the A/E may observe the inspections, tests or approvals. If such special inspection or testing reveals a failure of the work to comply with the requirements of the Contract Documents, the Contractor shall bear all costs thereof, including compensation for the A/E’s additional services made necessary by such failure; otherwise the Owner shall bear such costs, and an appropriate Change Order shall be issued.

D. Concealed lines shall be tested before being concealed. If this is not done and a leak appears during the final test, this Contractor shall repair leak and all damage resulting therefrom.

E. This Contractor shall adjust all his equipment in the mechanical system to obtain proper operation and shall demonstrate to Owner and the A/E that the entire system will function properly.

PART 2 PRODUCTS
Not Applicable

PART 3 EXECUTION

3.01 After work has been completed but before pipe covering has been applied, the Contractor shall test the systems as follows. At these pressures, the circulation shall be free and the piping free of leaks.

<table>
<thead>
<tr>
<th>System</th>
<th>Test Medium</th>
<th>Pressure Not Less Than</th>
<th>Time Not Less Than</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heating Water</td>
<td>Water</td>
<td>125 lbs</td>
<td>24 hrs</td>
<td>no drop</td>
</tr>
<tr>
<td>Condensation Drains</td>
<td>Water</td>
<td>125 lbs</td>
<td>6 hrs</td>
<td>no drop</td>
</tr>
<tr>
<td>Make-up Water</td>
<td>Water</td>
<td>125 lbs</td>
<td>24 hrs</td>
<td>no drop</td>
</tr>
</tbody>
</table>

TESTS AND ADJUSTMENTS
3.02 Balancing Water Systems:

A. This Contractor shall procure the services of an independent company which specializes in the testing and balancing of the chilled water system. All balancing work shall be done under the direct supervision of a qualified Heating and Ventilating Engineer. It shall be the responsibility of this Contractor to make all necessary arrangements with the Balancing Company for balancing the air and water systems after all equipment, ductwork, outlets, piping and accessories have been installed. A detailed report on all balancing work shall be prepared and submitted, in triplicate, to the Owner's Representative for review. Each copy of the report shall be dated, signed by the supervising Engineer of the Balancing Company and bound in a suitable cover. The Balancing Company shall be selected by the Contractor from the following qualified firms:

1. Kahoe Air Balance Company
2. Any member of the AABC or NEBB

B. Balancing procedures and report to be in accordance with procedures set forth by the Associated Air Balance Council. Report shall also include fan curves for all equipment.

C. During the bid period, the Balancing Contractor shall call the HVAC Contractor's attention to any requirements for additional balancing dampers, test ports, gage cocks, thermometer wells, flow control devices, valves, balancing valves and fittings and manual volume dampers which are deemed necessary in addition to those shown on the drawings so that proper balancing can be performed. Prior to installation of the systems, the Balancing Contractor shall verify that the proper number and location of balancing devices are adequate for completion of the balancing work.

C. Where Pete's Plugs are installed, report shall include pressure drop readings across chillers, etc., to confirm flow rates.

D. Balance reports shall include starter element sizes, and amperage ratings for each motor. If starter elements amperage rating is more than 10 percent greater or less than motor nameplate amperage, this Contractor shall inform the Electrical Contractor to furnish and install proper size elements. Balance report shall include the corrected proper size starter element sizes and amperage ratings.

E. Balance Contractor shall report by letter to the A/E on preliminary results of balancing before the final balance report is prepared. This report shall include any problems encountered during balancing or major deviations from specified conditions.

F. If required, a meeting shall be arranged between this Contractor, the Balance Contractor and the A/E to resolve any problems or deviations from the Contract Drawings and Specifications before the final balance work is completed and final report is submitted for review by the A/E.

G. Verify that all equipment start-up services have been completed before the beginning of any TAB work. After initial start-up has been completed the TAB contractor shall be informed that the systems are operating properly, that all safety interlocks and protective devices are functioning, and the systems are ready to be balanced.
H. Meet with owners and A/E’s representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team members, equipment manufacturers’ authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days advance notice of scheduled meeting time and location.

I. Prepare a TAB plan that includes strategies and step-by-step procedures. This plan should include a list of items that must be completed before TAB can proceed. Prepare a schedule to ensure adequate time for the TAB process and submit this schedule to the responsible party to be part of the Project Construction Schedule.

3.03 Water Balance

A. Each water circulating system, when installation is completed, shall be set in operation for balancing. Water flow thru each pump, chiller and balancing valve a shall be determined by pressure differential gauging or direct reading. Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Flows shall be balanced to quantities listed on the drawings within plus or minus 5%.

B. Check and compare expansion tank set-up data to design requirements for proper operation. Report any deviations to HVAC Contractor and Owner’s Representative for corrective action.

C. Check flow-control valves and set to indicated flow.

D. Verify pump data - pump-motor brake horsepower and impeller size on nameplate data on the pump to design submittals.

E. Pump tests shall show full flow and dead head conditions. Do not throttle valves on the pump discharge. Pump flow control valves shall not be closed more than fifty percent. Pump flow control valves, which require more than fifty percent closure shall be reported to the contractor and engineer for evaluation of valve sizing and selection. Automatic valves shall be fully open during testing of the unit associated with the control valve.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads and systems’ pressures and temperatures including outdoor air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

H. The report shall include, but not be limited to, both actual and design water quantities, pressures in and out of each device, pump motor data, operating voltage and amperage and pump curves.

I. Mark equipment and balancing device setting with paint or other suitable, permanent identification material, including valve-control positions, valve position indicators and similar controls and devices, to show final setting.

3.04 After completion of the balancing work, a full report shall be prepared in pencil and two copies (only) submitted to the Engineer for preliminary review. After review, additional balancing, adjustments, drive replacements, readings and recordings deemed necessary shall be done and the report revised. Six typed copies of the final report shall be submitted thru the HVAC Contractor to the Engineer for review and approval. An approved copy of the report shall be included in each set of operating and maintenance manuals.
Miami University
Culinary Support Center Boiler & BAS Upgrades
Oxford, Ohio

END OF SECTION 23 05 93
SECTION 23 05 94
PROTECTION AND CLEANING

PART 1 GENERAL

1.01 REFERENCE

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.

PART 2 PRODUCTS

Not Applicable

PART 3 EXECUTION

3.01 Protect all mechanical equipment against damage from any cause whatsoever and pay the cost of replacing and repairing equipment made necessary by failure to provide suitable protection.

3.02 After all piping, equipment has been approved and after all plastering has been completed, bare piping and insulation provided under this Contract shall be thoroughly cleaned of dirt, grease, rust and oil.

3.03 Repair all dents and scratches in factory prime or finish coats on all mechanical equipment to the satisfaction of A/E. If damage is excessive, replacement may be required.

3.04 Flush out all piping systems to remove all dirt and grease from pipes and equipment before systems are placed in operation. Clean strainers after each flushing until the strainer remains clean.

3.05 The HVAC Contractor shall clean all water piping systems under this Contract. After systems have been flushed thoroughly and drained, clean as follows:

A. Completely fill, air vent, and circulate systems for four (4) hours at design temperatures with the following solution:

One pound of trisodium phosphate for each 50 gallons of water or one pound of sodium carbonate for each 30 gallons of water.

B. Completely drain and refill with fresh clear water.

C. After venting and circulating, check pH.

D. If system pH is below 7, add small amounts of cleaner until pH is between 7 and 8.

3.06 Cover all motors, pumps, open pipes, etc., to keep out dirt, water and weather during construction.

3.07 The HVAC Contractor shall clean up and remove all debris from the site and shall at all times keep the premises in a neat and orderly condition.
3.08 In addition to the provisions and stipulation of the General Conditions, the HVAC Contractor shall provide various types of protection as follows:

   A. Protect finished floors from chips and cutting oil by the use of metal drip receiving pan and oil proof floor cover.

   B. Protect equipment and finished surfaces from welding and cutting spatters with baffles and spatter blankets.

   C. Protect equipment and finished surfaces from paint droppings, insulation adhesive and sizing droppings, etc., by use of drop cloths.

3.09 All equipment shall be stored at the site with openings, bearings, etc., covered to exclude dust and moisture. All stock piled pipe shall be placed on dunnage and protected from weather and from entry of foreign material.

3.10 Conduit and construction openings and excavations required for HVAC work shall be covered when work is not in progress, as follows:

   1. Cap pipe openings with fittings or plugs.

   2. Cover wall and ceiling openings with plywood, or canvas covered framing.

   3. Cover floor openings and excavations with structural material of adequate strength to support traffic.

3.11 The University's property and the property of other Contractors shall be scrupulously respected at all times (including damage from leaks). Provide drop cloths and visqueen or similar barriers where dust and debris is generated, to protect adjacent areas.

3.12 HVAC Contractor shall be held responsible for damage caused by his work or through neglect of his workmen. Repairing of damaged work shall be done by HVAC Contractor. Cost of repairs shall be paid by HVAC Contractor.

3.13 The University reserves the right to make emergency repairs as required to keep equipment in operation without voiding the HVAC Contractor's guarantee bond not relieving the HVAC Contractor of his responsibilities during the bonding period.

3.14 Exercise care in cleaning and lubrication of bearings after equipment has been subjected to prolonged periods of storage before operating the HVAC Contractor shall be responsible for continued lubrication of equipment until acceptance of this work.

END OF SECTION 23 05 94
SECTION 23 07 00 - HVAC INSULATION

PART 1 GENERAL

1.01 SCOPE

A. Extent of Work - Insulate pipes and other surfaces as follows:

Hot Water Heating Piping
Pump Casings
Cold water makeup piping

B. Repair all existing insulation damaged by work of this project in kind and to match existing covering.

PART 2 PRODUCTS

2.01 All insulating materials, including jackets, cements, adhesives, vapor barriers, etc., shall be U.L. listed with a flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50.

2.02 Molded plastic fitting covers shall be U.L. approved with a flame spread rating not to exceed 25 and a smoke developed rating not to exceed 50.

2.03 Pipe insulation shall be Johns Manville "Micro-Lok" glass fiber insulation rated for 850°F. with factory applied AP-1 all purpose, self-sealing vapor barrier jacket. Butt strips shall be minimum 3" wide of same material as jacket.

2.04 Insulation for chilled water pump casings shall be 25/50 rated flexible closed cell, elastomeric Armstrong Armaflex II sheet and roll insulation, rated for -40°F to 220°F.

2.05 Duct insulation shall be Johns Manville rigid type as noted with FSK glass fiber reinforced foil faced flame resistant kraft paper vapor barrier facing.

2.07 All fiberglass cover above shall be by Johns Manville. Equivalent type thickness and conductivity insulation by Owens Corning, Knauf, or CertainTeed meeting all requirements may be furnished at the Contractor's option.

2.08 All elastomeric cover above shall be by Armstrong. Equivalent type thickness and conductivity insulation by Aerotube, Halstead, Imcoa or Rubitex meeting all requirements may be furnished at the Contractor's option.

2.09 Insulation thicknesses are based on insulation having thermal resistance in the range of 4.0 Hr F ft²/BTU to 4.6 Hr F ft²/BTU per inch of thickness on a flat surface at a mean temperature of 75°F. Minimum insulation thickness shall be increased for materials having R values less than 4.0 or may be reduced for materials having R values greater than 4.6 to give equivalent "R" values.

2.10 All mastics, adhesives, sealers etc., shall have low VOC emittance.

PART 3 EXECUTION

3.01 Insulation Thickness Table
A. In the absence of a specified insulation thickness, the following table shall apply:

### MINIMUM PIPE INSULATION
### INSULATION THICKNESS IN INCHES
### FOR PIPE SIZES

<table>
<thead>
<tr>
<th>Piping System Types</th>
<th>Fluid Temperature</th>
<th>Runouts up to 2”**</th>
<th>1” and less</th>
<th>1-1/4 to 2”</th>
<th>2-1/2” to 4”</th>
<th>5” to 6”</th>
<th>8” and larger</th>
</tr>
</thead>
<tbody>
<tr>
<td>HEATING SYSTEMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Steam and hot water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Pressure/Temp</td>
<td>306-450</td>
<td>1-1/2</td>
<td>1-1/2</td>
<td>2</td>
<td>2-1/2</td>
<td>3-1/2</td>
<td>3-1/2</td>
</tr>
<tr>
<td>Med Pressure/Temp</td>
<td>251-305</td>
<td>1-1/2</td>
<td>1-1/2</td>
<td>2</td>
<td>2-1/2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Low Pressure/Temp</td>
<td>201-250</td>
<td>1</td>
<td>1</td>
<td>1-1/2</td>
<td>1-1/2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Low Temperature</td>
<td>120-200</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1-1/2</td>
</tr>
<tr>
<td>Steam Condensate</td>
<td>Any</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1-1/2</td>
<td>1-1/2</td>
</tr>
<tr>
<td>COOLING SYSTEMS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chilled Water</td>
<td>40-55</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

*Runouts not exceeding 12 ft. in length to Individual Terminal Units.

3.02 Insulate Steam Piping as follows:

A. Cover all piping with glass fiber pipe insulation. Minimum insulation thickness to be as shown in Table 3.01.

B. Fittings for low pressure steam piping shall be wrapped with compressed fiberglass to same thickness as the adjacent pipe insulation and covered with a molded plastic fitting.

C. Fittings for high pressure steam piping shall be wrapped with compressed fiberglass to same thickness as the adjacent pipe insulation and secured with stretchable glass fabric jacket and adhesive.

D. Flanges, valves and unions in lines below 15 psi shall not be covered.

E. Flanges, valve bodies and unions in lines above 15 psi shall be wrapped with compressed fiberglass to the same thickness as adjacent pipe covering and secured with stretchable glass fabric jacket and adhesive.

F. Finish insulation on all piping in mechanical rooms, tunnels, storage rooms and in exposed locations with glass cloth (minimum 6 x 6 weave/inch, 4.3 ounces per square yard) vapor barrier jacket applied with Foster No. 30-36 and two coats No. 30-42 over glass cloth. In lieu of the glass cloth and mastic specified, a 14.3 oz. rewettable glass cloth equal to Alpha Maritex Style 84217/9485 RW may be used at the Contractor’s option.

H. Existing steam piping that remains and is currently not insulated shall be insulated as described above. The scope of insulation of existing piping is indicated on the Drawings.

3.03 Cover all flanges, valves and unions in steam lines above 15 psi with flexible/removable covers similar to Flexpak Type M1-20K1-M1S1/C4 to be constructed inside and outside of the following:

1. Knitted 0.011” 60 mesh density type 304 stainless steel mesh liner.

2. Two inch thick non-combustible 1200°F. fiberglass insulation equivalent to Burglass 1200.
3. Knitted 0.011" 60 mesh density type 304 stainless steel mesh.
5. Stainless steel lacing hooks and stainless steel wire fasteners.

Flexpak is manufactured by O-Brien Corporation, 1919 Hampton Avenue, St. Louis, Missouri 63139, telephone (314) 645-8080.

3.04 Cover hot water heating, steam condensate and condensate pump discharge piping as follows:
A. Cover all piping with glass fiber pipe insulation. Minimum insulation thickness to be as shown in the Table (3.01).
B. Fittings shall be wrapped with compressed fiberglass to same thickness and density as adjacent pipe insulation and covered with a molded plastic fitting.
C. All mechanical couplings shall be wrapped with compressed fiberglass to the same thickness as adjacent pipe insulation and covered with a molded plastic fitting.
D. No covering required on supply and return lines inside heating units cabinets.
E. Valves, flanges and unions shall not be covered. Insulation shall be stopped square with valves, etc., and ends sealed with Benjamin Foster "Tight Fit" coating.
F. Finish insulation on all piping in mechanical rooms, tunnels, storage rooms and in exposed locations with glass cloth (minimum 6 x 6 weave/inch, 4.3 ounces per square yard) vapor barrier jacket applied with Foster No. 30-36 and two coats No. 30-42 over glass cloth. In lieu of the glass cloth and mastic specified, a 14.3 oz. rewettable glass cloth equal to Alpha Maritex Style 84217/9485 RW may be used at the CM's option.
   1) Knauf pipe insulation with an ASJ + jacket or Ownes Corning insulation with "Evolution" paper free ASJ may be used in place of the above specified glass cloth.

3.05 Cover chilled water piping as follows:
A. Cover all piping with glass fiber pipe insulation. Minimum insulation thickness to be as shown in Table 3.01.
B. Butt all edges of insulation and seal all longitudinal laps and butt strips with white vapor barrier cement similar to Foster No. 85-20, or factory self-sealing laps.
C. Fittings shall be wrapped with compressed fiberglass to same thickness and density as adjacent pipe insulation and covered with a molded plastic fitting.
D. All valves (including bonnet), flanges, unions, etc. shall be covered with full thickness insulation and jacket.
E. Use 12" long sections of calcium silicate insulation with jacket same as adjacent pipe covering at each hanger. At the CM's option, install a treated wood block or high density (20 lb./ft.³) fiberglass block at each hanger. Vapor barrier to be maintained throughout.
F. All mechanical couplings shall be wrapped with compressed fiberglass to the same thickness as adjacent pipe insulation and covered with a molded plastic fitting.

G. Finish insulation on all piping in mechanical rooms, tunnels, storage rooms and in exposed locations with glass cloth (minimum 6 x 6 weave/inch, 4.3 ounces per square yard) vapor barrier jacket applied with Foster No. 30-36 and two coats No. 30-42 over glass cloth. In lieu of the glass cloth and mastic specified, a 14.3 oz. rewettable glass cloth equal to Alpha Maritex Style 84217/9485 RW may be used at the CM’s option.

1) Knauf pipe insulation with an ASJ + jacket or Owens Corning insulation with “Evolution” paper free ASJ may be used in place of the above specified glass cloth.

3.06 Cover cold water make-up and condensation drain piping as follows:

A. Cover all piping with 1/2” thickness glass fiber pipe insulation.

B. Seal all laps and butt strips with white vapor barrier cement or factory self-sealing laps.

C. Fittings shall be wrapped with compressed fiberglass to same thickness and density as adjacent pipe insulation and covered with a molded plastic fitting.

D. All valves (including bonnets), flanges, unions, etc. shall be covered with full thickness insulation and jacket.

E. Finish insulation on all piping in mechanical rooms, tunnels, storage rooms and in exposed locations with glass cloth (minimum 6 x 6 weave/inch, 4.3 ounces per square yard) vapor barrier jacket applied with Foster No. 30-36 and two coats No. 30-42 over glass cloth.

1) Knauf pipe insulation with an ASJ + and jacket or Owens Corning insulation with “Evolution” paper free ASJ may be used in place of the above specified glass cloth.

3.07 Insulate Rectangular Supply Air, Mixed Air, Relief Air from Control Damper to Outside, Outside Air Ducts and Plenums and Exhaust Air ducts and Plenums Downstream of the Heat Recovery Coil in Equipment Rooms. Cover as follows:

A. Insulate outside and relief air ducts with 3” thick, supply return and mixed air ducts with 1” thick, 6 lb./cu. ft. density rigid duct insulation. Insulation shall be applied with edges tightly butted and secured by impaling on pins welded to the duct or cherry rivet pins. Pins shall be on spacing to hold insulation firmly against duct surface. Speed clips approximately 1-1/2” square shall be pushed over the pins to hold the insulation, after which, the pins shall be clipped off close to the insulation. Insulation may be secured to top of ducts with adhesive.

B. Seal all breaks and joints in vapor barrier with 2-1/2” wide pressure sensitive tape to match vapor barrier facing. Adhere with Foster's 85-20 adhesive where necessary.

C. Wrap insulation on all exposed ducts with glass cloth (minimum 6 x 6 weave/inch, 4.3 ounces per square yard) adhered and coated with Foster No. 30-36 coating.

3.08 Cover all high pressure supply air ducts as follows:
A. All ducts shall be insulated with 1-½" thick, 1 lb. density blanket flexible duct insulation.

B. Adhere insulation to duct surface with Foster No 85-20 adhesive applied in 6" wide strips on 12" centers. Butt all edges of insulation and seal all joints with a foil-skrim-kraft tape or flange adhered over the joint. Secure insulation with flare door staples until the adhesive sets.

C. Seal all breaks and joints in vapor barrier with 2-½" wide pressure sensitive tape to match vapor barrier facing. Adhere with Foster 85-20 adhesive where necessary.

D. Wrap insulation on all exposed ducts and supply ducts within equipment rooms with glass cloth (minimum 6 x 6 weave/inch, 4.3 ounces per square yard) adhered and coated with Foster No. 30-36 coating.

E. High pressure ductwork furnished with inner insulation for sound attenuation, as indicated on the Drawings, does not require exterior insulation.

F. Cover all variable air volume and mixing box necks.

3.09 Cover all low pressure supply air ducts not in equipment rooms as follows:

A. All supply air ducts shall be insulated with 1-½" thick, 1 lb. density blanket flexible duct insulation.

B. Adhere insulation to duct surface with Foster No. 85-20 adhesive applied in 6" wide strips on 12" centers. Butt all edges of insulation and seal all joints with a foil-skrim-draft tape or flange adhered over the joint. Secure insulation with flare door staples until the adhesive sets.

C. Seal all breaks and joints in vapor barrier with 2-½" wide pressure sensitive tape to match vapor barrier facing. Adhere with Foster 85-20 adhesive where necessary.

D. Cover all round low pressure ductwork (including that on the downstream side of the air terminal boxes).

E. Wrap insulation on all exposed ducts with glass cloth (minimum 6 x 6 weave/inch, 4.3 ounces per square yard) adhered and coated with Foster No. 30-36 coating.

F. Low pressure ductwork not in equipment rooms which is required to be lined per Specification Section 23 31 13.13 does not require wrapping.

3.10 Cover the top of all supply diffusers above ceilings when not in a return air plenum. Insulation to be 1-½" thick, 1 lb. density flexible blanket.

3.11 Wrap hot water reheat coils when installed in ductwork or connected to terminal boxes in air conditioning systems. Insulation shall be 1-1/2" thick, 1 lb. density blanket flexible duct insulation properly sealed with adjacent insulation or ductwork.

3.12 Cover pump casings as follows:

A. Insulate with 1" thick elastomeric sheet insulation.

B. Do not cover permanent labels or nameplates.
3.13 Cover heat exchangers including heads as follows:

A. Insulate with 3" thick glass fiber pipe insulation.

B. Do not cover permanent labels or nameplates.

C. Insulation for heads shall be assembled and installed with sheet metal cover.

D. Bevel insulation back neatly at flanges.

E. Finish with glass cloth (minimum 6 x 6 weave/inch, 3.3 ounces per square yard) adhered and coated with Foster No. 30-36 coating.

3.14 Application shall be made on clean, dry surfaces with all joints butted firmly together.

3.15 All supply air conditioning ducts and all chilled water pipe insulation to be continuous through floors, walls, ceilings, roofs and pipe hangers.

3.16 No insulation is required on pipes which are underground or buried under floor slab.

3.17 Insulation shall not be applied until the general construction has progressed sufficiently to insure against physical or moisture damage to the insulation. All damaged insulation shall be replaced at this CM's expense.

3.18 Install 20 gauge galvanized steel insulation protectors on all insulated exposed pipes passing through floor. Sleeves to be 12" above the floor.

3.19 Hanger rods must be perpendicular before insulation is installed.

3.20 Longitudinal lap joints and butt strips for glass fiber pipe insulation shall be secured with staples or three (3") inch centers and sealed with an approved vapor barrier adhesive where applicable. Staples are not required when insulation utilizes a "double" adhesive self sealing system.

END OF SECTION 23 07 00
PART 1  GENERAL

1.01  REFERENCE

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.

B. Section 23 05 30 - INSTALLATION OF PIPING.

C. Section 23 07 00 - HVAC INSULATION.

1.02  SCOPE

A. From the new boilers located in the basement provide a system of heating hot water piping to the heating water pumps and connect to the existing heating hot water mains.

B. From the the existing heating hot water mains provide a system of heating hot water piping to all new and VAV box reheat coils.

PART 2  PRODUCTS

2.01  Pipe - Schedule 40 black seamless or electric welded ASTM A-53, Grade A with Schedule 40, 150 lb. swp steel welding fitting, except 2" and smaller pipe option 125 lb. cast iron screwed fitting. Elbows shall be long radius type.

2.02  Fittings for piping 2-1/2" and smaller - 125 lb. black cast iron except the Contractor may, at his option, use weld joints in piping 1-1/2" and larger. Use standard weight welding fittings.

2.03  Fittings for piping 3" and larger - standard weight welding fittings.

2.04  At the Contractor's option, welloets, butt or threaded type, may be used for branch connections that are less than 2/3 main size. Use welded or screwed fittings for branch connections 2/3 main size or larger. Shaped nipples are not acceptable.

2.05  The Contractor, at his option, may use copper pipe and fittings for all pipe less than 4". Pipe shall be Type L hard drawn copper tubing with wrought copper solder type fittings. All joints shall be made with a 6 percent silver alloy with a 1000°F solidus minimum.

PART 3  EXECUTION

3.01  Install water mains without pitch. Use eccentric reducing couplings at changes in size, with top of pipes at same elevation. Use concentric reducers in vertical mains.

3.02  Branches to units below mains to be taken from bottom of mains at a 45 degree angle, pitch downward toward units. Branches to units above mains to be taken from top of mains at a 45 degree angle, pitched upward toward units. Pitch not less than 1" in 10'.
3.03 Install manual air vents at high points of the system, as shown on the Drawings and as required for proper air venting of system. Automatic air vents shall be provided in the supply and return piping to air handling unit heating coils.

END OF SECTION 23 21 13.23
PART 1   GENERAL

1.01   REFERENCE

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

B. Section 23 01 05, Paragraph 1.05 - OHIO ENERGY CODE

C. Section 23 05 13 - ELECTRICAL WORK

1.02   SCOPE

A. Provide end suction, flexible coupled pumps as shown on the Drawings.

B. Provide piping to the pumps as shown on the Drawings.

1.03   SUBMITTALS

A. Provide dimensional drawings and product data on each pump.

B. Provide pump curves for each pump at the specified operation point, with the flow, pressure and horse power clearly plotted.

C. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, alignment, receiving, handling, storage, safety information and cleaning. Provide a troubleshooting guide, parts list, warranty and electrical wiring diagrams.

1.04   QUALITY ASSURANCE

A. Each pump shall be given a vibration and pump alignment analysis by the manufacturer's representative.

B. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.

1.05   DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual.

C. Handling: Handle and lift pumps in accordance with the manufacturer’s instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.
1.06 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the date of occupancy.

2. Motor Warranty is warranted by the motor manufacturer for a period of one year from the date of occupancy.

PART 2 PRODUCTS

2.01 End suction, flexible coupled pumps shall be vertical split case, single stage, stainless steel impeller centrifugal type with bronze case wearing rings, ball bearings, motors, flexible couplings, coupling guards, drip pan and channel steel bases unless otherwise noted. Pumps shall be serviceable without the need to disconnect suction and discharge piping from the pump casing.

A. Manufacturer – Bell & Gossett Series E-1510

2.02 All pumps shall be furnished with bronze shaft sleeves and a single inside unbalanced mechanical shaft seal for leakless operation. A suitable arrangement shall be provided to furnish a portion of the pumped liquid to lubricate and cool the seal faces. Seals shall be rated for 250°F. water temperature. Seals shall be suitable for use with the specified glycol solution.

2.03. Pump volute shall be made of ductile iron with integrally cast pedestal support. The impeller shall be cast bronze, enclosed type, statically and hydraulically balanced. Impeller shall be keyed to the shaft and secured by a hex head impeller nut and washer.

2.04. Pump shall be rated for a minimum of 175 psi working pressure. Casings shall be provided with tapped and plugged holes for priming, vent, and drain.

2.05. Pump bearing housing shall have heavy duty re-greaseable ball bearings.

2.06 Base plate shall be channel steel, sufficiently rigid to support the pump and driving motor. A flexible-type coupler, capable of absorbing torsional vibration, shall be employed between the pump and motor, and it shall be equipped with a suitable coupling guard as required. HVAC Contractor to level and grout each unit according to manufacturer's instructions.

2.07 Pump capacities shall be as shown on the Drawings at total head noted. The operating point of each pump at the conditions shown shall be within five (5) percentage points of the maximum efficiency on its impeller curve. The impeller furnished shall not exceed 90 percent of the maximum diameter catalogued impeller available for the pump casing furnished. To assure stable pump operation, the impeller curve shall be continuously rising throughout the range contained within its efficiency curves. The peak of the impeller curve at maximum total head shall be a minimum of 10 percent above the total head shown on the Drawings. The pump shall not overload the motor at any point on the impeller curve.

2.08 Motors shall be 460 volt, 1750 RPM as indicated on the drawings, 60 Hertz, three phase, maximum 40°C ambient, open drip-proof with grease packed bearings and grease seals and fittings. Size of motors shall be as indicated on the Drawings. Motors shall be premium efficiency
type rated for use with variable frequency inverters. Efficiency at 1/4, 1/2, 3/4 or full load shall not be less than 91%.

A. Pump and motor shall be factory aligned, and shall be realigned by HVAC Contractor after installation.

2.09 Motor horsepower shall not be smaller than that scheduled. Pump furnished must operate within 5% of efficiency noted on Drawings and meet all other requirements specified.

2.10 Pumps shall be sensored and controlled by a variable frequency drive.

2.11 Pumps by Peerless or Armstrong of the same type, size and capacity may be furnished at the Contractor's option. Pumps furnished must operate within 5% of efficiency noted on drawings and meet all other requirements specified.

PART 3   EXECUTION

3.01 Install suction diffusers at suction of the new pumps.

3.02 Pump Alignment - The HVAC Contractor, before starting any pumping unit with pump and driver mounted on a common base plate with a flexible coupling, shall check the following points:

A. Make sure base plate is level in both directions.

B. Make sure pump shaft and driver shaft are parallel in both horizontal and vertical planes.

C. Make sure shafts are concentric.

D. Align coupling flanges for concentricity to assure that the face and curved edges are concentric within the manufacturer's recommendations.

E. Align coupling for angular alignment to tolerances recommended by the manufacturer.

F. Align coupling for parallel alignment.

G. The final coupling alignment shall be documented and the results furnished in writing to the A/E. Field check all alignments and report the maximum angular and eccentric misalignments to the nearest 0.001 inch.

3.03 Starters, disconnects and wiring by HVAC Contractor.

3.04 Install pumps on 4" high concrete pads by the HVAC Contractor.

3.05 Install flexible connectors on suction and discharge sides of pumps.

3.06 Install a vent cock on the volute casing.

3.07 Mount pumps as shown on the drawings.

3.08 Support vertical piping drops from floor or isolation base to avoid stress on pump connections.

3.09 Pipe the pump base drip lips to the nearest floor drain.

END OF SECTION 23 21 23
SECTION 23 21 23.14

IN-LINE PUMPS

PART 1 GENERAL

1.01 REFERENCE

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.
B. Section 23 01 05, Paragraph 1.05 - OHIO ENERGY CODE
C. Section 23 05 13 - ELECTRICAL
D. Section 23 21 23.14 – HOT WATER HEATING PIPING SYSTEM
E. Section 25 00 00 - TEMPERATURE CONTROLS
F. Section 25 00 01 - SEQUENCES OF OPERATION

1.02 SCOPE

A. Provide two wet rotor in-line pumps to serve the new heating water boilers. The unit shall be provided with integral variable frequency drive and controlled by the boiler control panel.
B. Provide one wet rotor in-line pump to serve the new side stream chemical feed system. The pump shall be constant volume.
C. Provide piping to the pumps as shown on the Drawings.

1.03 SUBMITTALS

A. Provide dimensional drawings and product data on each pump.
B. Provide pump curves for each pump at the specified operation point, with the flow, pressure.
C. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, pump alignment, receiving, handling, storage, safety information and cleaning. Provide a troubleshooting guide, parts list, warranty and electrical wiring diagrams.

1.04 QUALITY ASSURANCE

A. Each pump shall be given a vibration and pump alignment analysis by the manufacturer.
B. Comply with the National Electrical Manufacturers Association (NEMA), standards for motors and electrical accessories.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.
B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer’s instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual.
C. Handling: Handle and lift pumps in accordance with the manufacturer’s instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.06 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

1. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the date of occupancy.

2. Motor Warranty is warranted by the motor manufacturer for a period of one year from the date of occupancy.

PART 2 PRODUCTS

2.01 In-line pumps shall be Bell & Gossett series E-80 as noted on the drawings.

2.02 Pumps shall have cast iron casing, flanged connections, bronze impeller, stainless steel shaft suction and discharge tappings.

2.03 Motors shall be synchronous, permanent magnet, wetted rotor, of horsepower and voltage shown on the drawings.

2.04 Pump capacities shall be as shown on the drawings at total head noted. The operating point of each pump at the conditions shown shall be within five (5) percentage points of the maximum efficiency on its impeller curve. The impeller furnished shall not exceed 90 percent of the maximum diameter catalogued impeller available for the pump casing furnished. To assure stable pump operation, the impeller curve shall be continuously rising throughout the range contained within its efficiency curves. The peak of the impeller curve at maximum total head shall be a minimum of 10 percent above the total head shown on the drawings. The pump shall not overload the motor at any point on the impeller curve.

2.05 Pumps shall be wetted rotor with fluid lubricated bearings, and suitable for 175 psig working pressure. The motor furnished shall be nonoverloading at any point on the pump curve.

2.06 Each pump/motor assembly shall be provided with an integral variable frequency drive with over/under voltage, over temperature, over current, locked rotor and no load protection.

A. Pump VFD shall have Modbus and BACnet connections along with 0-10 volt and 4-20 MA analog inputs.

B. Pump VFD shall have the following operating modes.

1. Proportional pressure
2. Constant pressure
3. Constant speed
4. Automatic night setback
5. Temperature set point
6. Temperature Delta T
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2.07 Pumps by Peerless or Armstrong of the same type, size and capacity may be furnished at the Contractor's option. Pumps furnished must operate within 5% of efficiency noted on drawings and meet all other requirements specified.

PART 3 EXECUTION

3.01 Install pipe hangers on piping within six inches of pump inlet and discharge on inline pumps. Do not support in-line pumps independently of piping.

3.02 Install pumps as indicated on drawings to include ball valves or butterfly valves on each side of pumps.

3.03 Starters, disconnects and wiring by the Electrical Contractor.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCE
A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.
B. Section 23 05 30 - INSTALLATION OF PIPING.

1.02 WORK INCLUDED
A. Provide a complete and working water treatment system as herein specified and indicated on the Drawings.
B. The water treatment supplier shall provide the following services:
   1. All preoperational system cleanout chemicals.
   2. Chemical feed equipment as described herein.
   3. All necessary test equipment for control of chemicals.
   4. Instruct the HVAC Contractor on precleaning procedures.
   5. Instruct the HVAC Contractor on the installation of the feed equipment.
   6. Provide training for the operating personnel.
   7. Provide one year field service and consultation which will include monthly service visits with written test results, recommended adjustments, and a written report to the Owner.
   8. Provide one year supply of chemical treatment.
   9. Provide laboratory testing of samples as needed.
   10. System Start-up assistance.
C. Provide a chemical treatment system for the closed loop water piping systems as shown on the Drawings.
D. HVAC Contractor shall include the cost of chemicals and a Service Contract as described below.

1.03 SUBMITTALS
A. Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1.04 QUALITY ASSURANCE
A. Coordination: Coordinate layout and installation of pot feeders/filters units with piping and with other installations.

1.05 SEQUENCING AND SCHEDULING
A. Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into base.

1.06 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.

PART 2 PRODUCTS

2.01 WATER TREATMENT-ONE YEAR’S SUPPLY
A. Closed Loop Heating Water Systems
1. Provide a liquid treatment for scale and corrosion protection in a multi-metal system. Treatment shall also provide dispersion of suspended solids. Coordinate chemical type with Miami University.

2. Chromates will not be accepted.

C. Pre-operational System Cleanout Specifications
1. All new circulating water systems, both open and closed, shall be thoroughly flushed out with Lombardi precleaning chemicals. These chemicals shall be circulated as directed by the Lombardi service technician. The system shall then be flushed with fresh water, drained a second time and refilled. All strainers shall be cleaned after this cleanout procedure. After final filling, the pH of the system water shall not exceed the pH of the fresh incoming water by more than .5 pH, and the system water shall have no remaining visible foreign matter.

2.02 Treatment, equipment and service shall be furnished by WEAS.

PART 3 EXECUTION

3.01 INSTALLATION
A. Furnish and install all mounts, piping, tubing and valves necessary to install the complete operable water treatment system as shown on the drawings and under the supervision of the chemical company.

B. Furnish a sufficient one year supply of chemicals to maintain all systems free of corrosion, scale, and biological growth. Chromates will not be accepted. The systems shall not be operated for temporary cooling or heating without chemical treatment.

C Furnish a one year service program by a qualified service person performing service on a full time basis. Service calls will be no less than one per month, but as often as required to keep all systems in balance. Service shall include supervision of installation of the feed equipment and start up of the systems when notified. Records of service calls shall be available for review.
D. Upon acceptance, the HVAC Contractor shall inform the Owner in writing as to the treatment applied during start-up and testing. The HVAC Contractor shall state specifically the chemicals used and the quality of the fluids in the systems, which shall include:

1. Total hardness  
2. Alkalinity  
3. pH  
4. Dissolved solids  
5. Suspended solids  
6. Sodium sulfite  
7. Phosphonate

3.02 In all locations where chemicals are dispensed, provide safety data sheets in "see-thru-folder" and posted in visible work area. Chemical supplier shall provide all special safety equipment required for handling chemicals.

3.03 The operation of the chemical treatment system shall be completely tested after the installation is complete.

END OF SECTION 23 25 13
PART 1 GENERAL

1.01 REFERENCE

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.

1. Section 23 01 05, Paragraph 1.05 - OHIO ENERGY CODE.
2. Section 25 00 00 - TEMPERATURE CONTROLS

1.02 SCOPE

A. Furnish and install a DDC variable volume, "pressure independent" medium velocity air terminal units with electronic operators for air volume control, access door, attenuator section and inlet valves. Size, capacity and noise level as shown on the drawings.

B. Boxes shall be provided with a direct digital controller and electronic actuator furnished and field installed by the Temperature Control Contractor.

1.03 SUBMITTALS

A. Provide dimensional drawings and product data on each VAV box.
B. Provide air flows and pressure drops for each VAV box at the specified operation point.
C. Provide sound power readings for the eight octave bands, decibels, and sones.
D. Provide manufacturer's certification that VAV boxes are licensed to bear ARI seal for sound and air performance.
E. Installation, Operation, and Maintenance Manual (IOM): Provide manufacturer's installation, operations, and maintenance manual, including instructions on installation, operations, maintenance, receiving, handling, storage, safety information and cleaning. Provide a troubleshooting guide, parts list, warranty and electrical wiring diagrams.

1.04 QUALITY ASSURANCE

A. Performance ratings: Conform to ARI standard 880.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Delivery: Deliver materials to site in manufacturer’s original, unopened containers and packaging, with labels clearly indicating manufacturer, material, products included, and location of installation.

B. Storage: Store materials in a dry area indoor, protected from damage, and in accordance with manufacturer's instructions. For long term storage follow manufacturer's Installation, Operations, and Maintenance Manual. Inlet and outlet duct connections along with piping connections shall be provided with temporary caps or covers to prevent entry of dirt and moisture.
C. Handling: Handle and lift fans in accordance with the manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage. Follow all safety warnings posted by the manufacturer.

1.06 WARRANTY

A. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under Contract Documents.

B. The warranty of this equipment is to be free from defects in material and workmanship for a period of one year from the date of occupancy.

PART 2 PRODUCTS

2.01 Variable volume medium velocity control box shall be Titus Type DESV.

2.02 Unit shall have factory catalogued performance ratings which conform to CFM, static pressure, discharge and radiated sound power and attenuation designated.

A. Cabinet shall be constructed of not lighter than 22 gauge, zinc-coated steel. (Without factory-applied enamel paint finish.) All terminal units must have an approved non-porous sealed lining system. Liner and insulation must meet requirements of UL 181 and NFPA 90A. All seams and cut edges must be sealed to prevent erosion while all discharge edges of the liner must be secured with metal brackets. Insulation shall be 4.0 lb/ft3 density. Lining shall be Fiber-Free Lining System by Titus or equivalent. Liners made by Mylar, Tedlar, Silane or woven fiberglass cloth are not acceptable.

B. Refer to schedule on Drawings for minimum airflows.

C. Performance of units shall be based on tests conducted in accordance with ADC Standard 1061Rs and ASHRAE Standard 36B.

D. Electronic operator shall be furnished and field installed by the Temperature Control Contractor.

E. Leakage of valves in fully closed position shall not exceed 2% of rated capacity at 4" w.g.

F. Automatic damper operators shall be field installed and thoroughly tested for proper performance.

G. Minimum inlet SP requirement shall not exceed 0.50".

2.03 The Temperature Control Contractor shall field mount and wire the DDC controllers for the VAV box.

2.04 Units shall be UL listed with a flame spread rating not to exceed 25 and a smoke development rating not in excess of 50.

2.05 Box shall be factory adjusted to deliver the specified air quantities within 5%. Each box shall be labeled with the capacity as adjusted and furnished with a calibration chart. Pressure taps shall be provided to measure pressure drop across unit to confirm CFM.
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2.06 Box shall be end outlet.

2.07 Box shall deliver the air quantities shown on the Drawings at sound levels not to exceed the manufacturer's published sound levels for the units indicated on the Drawings.

2.08 Box shall be furnished with a minimum 2-row reheat coil with aluminum fins and copper tubes. Provide access door in VAV box upstream of coil.

2.09 All boxes shall be furnished with an attenuator section.

2.10 All boxes shall be furnished with a discharge air sensor. Each sensor shall be provided and installed by the Temperature Control Contractor.

2.11 Variable Air volume boxes by Trane, or Price, meeting all specified requirements, may be furnished at the Contractor's option.

PART 3 EXECUTION

3.01 Provide flexible connection at inlet to the box. Box shall be installed with at least two duct diameters of rigid straight duct attached directly to box inlets.

3.02 Support the units from the building structure with solid steel hanger rods or sheet metal strap hangers from corner points of unit, minimum 4, such that unit is self-supporting. Units shall not be supported from the duct system or piping system or ceiling suspension system.

3.03 The air control terminal box locations must be coordinated with all elements that shall be in or above the ceiling. This includes but is not limited to HVAC piping, plumbing piping, conduit, wiring, junction boxes, pull boxes, lighting fixtures, sprinkler heads, cable tray, speakers, smoke detectors air devices, etc. In no case shall the Contractor mount an air control terminal above a lighting fixture, speaker, diffuser or any other device mounted on the ceiling without written permission from the University. Provide ceiling access panels where the ceiling system does not afford ready access.

3.04 Provide a manual-automatic air vent at the coil.

3.05 Operating sequence of boxes shall be as described under Section 25 00 01 – Sequences of Operation.

3.06 Low voltage power and communications wiring shall be by the Temperature Control Contractor.

END OF SECTION 23 36 16
PART 1 GENERAL

1.01 REFERENCES

A. Section 23 01 05, Paragraph 1.05 - OHIO ENERGY CODE
B. Section 23 05 13 - ELECTRICAL WORK

1.02 SCOPE

A. Furnish gas fired boilers in the Mechanical Room. Boilers shall be furnished with all appurtenances as hereinafter specified and as shown on the drawings.

1.03 SUBMITTALS

A. Product Data: For each type of product.

1. Shop Drawings: For boilers, boiler trim, and accessories. Include product description, model number, dimensions, clearances, weights, components and options.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.
   a. Schematic wiring diagram of boiler control system of the ladder-type showing all components, interlocks, etc. Schematic wiring diagram shall clearly identify factory wiring and field wiring by others.
   b. Detail wiring for power, signal, and control systems.

1.04 INFORMATION SUBMITTALS

A. Manufacturer’s Certification: The boiler manufacturer shall certify the following:
1. The products and systems furnished are in strict compliance with the specifications.
2. The boiler, burner, and other associated mechanical and electrical equipment have been properly coordinated and integrated to provide a complete and operable boiler package. ASME Certification in the form of ASME Stamp on the product and completed and signed data sheet.
3. ASME CSD-1 Certification, in the form of completed data sheet.
4. cULus Certification in the form of an affixed label to the equipment.
5. The specified factory tests have been satisfactorily performed.
6. The specified field tests have been satisfactorily performed.
7. Manufacturer’s printed operation and maintenance manuals shall be submitted prior to final acceptance by the engineer. Operation and maintenance manuals shall contain dimension and wiring drawings, product data, operating instructions, cleaning procedures, replacement parts list, maintenance and repair data, complete parts list, etc.
1.05 WARRANTY

The below warranties are specific to the CFC-E product. If equipment warranties are critical to the owner, discuss the extensive CFC-E warranty compared to industry standards and competition. Review specific job warranty requirements with owner, and overall project requirements.

B. Manufacturer's Warranty: Manufacturer agrees to repair or provide replacement components of boilers that fail in materials or workmanship within specified warranty period.

Verify available warranties and warranty periods for units and components specified.

1. Warranty Period for Fire-Tube Condensing Boilers:
   a. The pressure vessel shall be guaranteed against thermal shock for 20 years when utilized in a closed loop hydronic heating system with a temperature differential of 120 °F or less. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.
   b. The pressure vessel, tubes and tube sheets (heat exchanger) shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 10 years. The condensate collection box shall be guaranteed for 20 years. The burner cylinder shall be warranted for a period of 5 years.
   c. All parts not covered by the above warranties shall carry a 1 year warranty from startup, or 18 months from shipment, whichever occurs first. This shall include all electrical components and burner components. One year labor warranty shall also be included.

1.06 PERFORMANCE REQUIREMENTS

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

B. ASME Compliance: Fabricate and label boilers to comply with the current version of the ASME Boiler and Pressure Vessel Code.

C. ASHRAE/IES 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."

D. AHRI Testing: The boilers shall be tested and certified per AHRI requirements for efficiency ratings.

E. UL Compliance: Test boilers for compliance with UL 795 and CAN1-3.1-77. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

F. CSA or cULus certified as an indirect or direct vent boiler and comply with standard CAN1-3.1-77.

G. Boiler and controls shall be compliant with ASME CSD-1 Code requirements.
PART 2 PRODUCTS

2.01 Subject to compliance with requirements, provide Cleaver Brooks Clearfire Boiler(s) model CFC-E as indicated on Drawings or approved equal:
   Cleaver Brooks – Model Clearfire CFC-E (Basis of Design)
   Lochinvar Crest
   Fulton Vantage
   Thermal Solutions Arctic

2.02 HIGH MASS FIRETUBE STAINLESS STEEL CONDENSING BOILERS

1. Retain "Manufacturers" Paragraph and list of manufacturers below to require products from manufacturers listed or a comparable product from other manufacturers.

   a. "Near condensing" copper fin designs, watertube, cast iron, cast aluminum, or "add-on" secondary condensing exchangers will not be considered. Boilers with minimum flow requirements also will not be considered.

   b. Description: Each unit shall be a down-fired firetube type complete with burner and automatic controls. The boiler, with all piping and wiring, shall be a factory package. Each boiler shall be neatly finished, thoroughly tested and properly packaged for shipping. Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 125 PSIG.

   A. Duplex stainless steel has superior corrosion resistance, and minimal thermal stresses compared to other grades of stainless steel. The counterflow design puts the coldest flue gases in contact with the coldest return water, maximizing condensing potential.

      a. Heat Exchanger: Duplex stainless steel tubes, tube sheets, and combustion chamber. The heat exchanger shall be a single-pass, counter-flow arrangement.

      b. The firetubes shall be duplex stainless steel, fitted with aluminum internal heat transfer fins.

      c. Pressure Vessel: Carbon steel with welded heads and tube connections.

      d. The boiler shall have one supply connection with dual return water connections. The dual return water connections shall enable the boiler to operate in a condensing mode when as little as 10% of the flow is returned to the low temperature return with a maximum temperature of 120°F.

   B. Water volume is crucial to the boiler’s ability to handle varying flow conditions and reduce cycling. Low water volume boilers are more susceptible to short cycling, and nuisance trips. They often have minimum and maximum flow requirements to protect the heat exchanger.

      a. The boiler pressure vessel shall have a minimum of 46 gallons of water volume/1000 MBH input.

   C. Many condensing boilers have minimum flow requirements. When designing a system, make sure all specified boilers can handle system design conditions.
a. The boiler shall be low flow tolerant without minimum flow requirements or the use of a flow switch.

D. Effective fireside heating surface has a direct correlation to the ability of the boiler to condense over a wide range of operating conditions. Since moisture in the flue gases condense on the surface of the tubes, greater amounts of fireside heating surface give the flue gases a larger area to condense on, leading to more efficient operation.

a. The boiler shall have a minimum of 250 sqft/1000 MBH of effective fireside heating surface.

E. If jobsite altitude exceeds 2000 ft ASL review equipment capacity and requirements with local Cleaver Brooks representative. Select natural gas or propane gas.

a. Burner: Natural gas, forced draft burner mounted in and integral with the boiler hinged top door so when the door is opened the burner head, furnace, tubesheet, and tube entrances are exposed. The burner door shall utilize easy removable threaded handles, and the burner shall swing upward on gas assist piston arms, one on each side to provide open support of the burner assembly.
   i. The burner shall be a linkage-less, self-regulating, air-fuel ratio gas valve-venturi system. Burner regulation shall be accomplished without the use of fuel/air mixing valves.
   ii. The burner shall achieve sub 20 ppm NOx when firing on natural gas at all firing rates.
   iii. Burner and fireside access shall be able to be performed by one service technician.

F. Select burner turndown will depending on boiler capacity.

a. Burner Head: shall be constructed of a stainless steel metal fiber for solid body radiation of the burner flame. Combustion shall take place on the surface of the burner mantle, which shall be constructed of a woven stainless steel metal fabric resulting a 360 degree low temperature radiant flame.

G. Optional 10:1 turndown on boilers from 500-2000 MBH

a. Burner shall be minimum 10:1 fully modulating turndown. (Natural gas)
b. Burner shall maintain no more than 7% O2 levels throughout the firing rate without additional sensors, linkages, or controls.
   1. The pre-mix design shall utilize a variable speed fan connected to a venturi to simultaneously modulate the fuel and air for a minimum 10:1 turndown. The valve-venturi design shall also act as a method for compensating for changes in barometric pressure, temperature, and humidity so the excess air levels are not adversely affected by changes in atmospheric conditions. External linkages and single speed fans shall not be acceptable.

c. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
d. The blower motor shall have a variable speed ECM motor with integrated drive electronics. Constant speed motors and variable frequency AC drives are not acceptable.
e. Gas Train: The gas train shall meet the requirements of CSA/UL and ASME CSD-1 and shall include:
i. Low Gas Pressure Interlock, manual reset.
ii. High Gas Pressure Interlock, manual reset.
iii. Upstream and downstream manual test cocks.
iv. Ball Type manual shutoff valve upstream of the main gas valve.
v. Unibody double safety gas valve assembly.
vi. Gas Pressure Regulator
vii. Union connection to permit burner servicing.

f. Ignition: Pilot ignition with 100 percent main-valve shutoff with UV scanner for flame supervision.

g. Combustion air proving switch shall be furnished to ensure sufficient combustion airflow is present for burner ignition firing.

h. To ensure that the flue is not blocked, the burner shall include a High Air Pressure Switch sensing the outlet pressure connection relative to stack backdraft.

i. Casing:

j. Jacket: 18 gauge metal cabinet with snap-in or interlocking closures.
k. Control Compartment Enclosures: NEMA 250, Type 1A.
m. Insulation: Minimum 2-inch thick, mineral-fiber insulation surrounding the heat exchanger.

H. CFC-E boilers come standard with direct vent connection for ducted combustion air, or room air can be utilized. For room air and direct vent, the combustion air filter kit can be used.

n. Combustion-Air Connections: Inlet and vent duct collars.

2.03 TRIM

1. Items A through F below are standard. Select other options as required for specific jobsite or Code requirements.

Safety valve(s) shall be ASME Section IV approved side outlet type mounted on the boiler air vent outlet. Size shall be in accordance with code requirements and set to open at 125 psig.

Temperature and pressure gauge shall be mounted on the water outlet.

Solid State Low water cut-off probe control with manual reset and test switch.

Manual Reset High Limit Temperature sensor; range not to exceed 210 deg F and shall be an integral device of the Boiler Burner Control and UL Recognized as a limit control.

Outlet water supply sensing probe for operating water limit setpoint.

Return water-sensing probe for operating limit setpoint.

Drain valve
Automatic air vent

2. Auxiliary low water cutoffs are rarely required for hot water boilers. Review and include only if required for specific jobsite or Code requirements.

3. The Cleaver-Brooks Falcon controls have visual indication and audible alarm standard. Only include this option if required for specific jobsite or Code requirements. Falcon audible alarm is 85dBA, separate horn is 100 dBA.

Alarm horn (electronic sounder)

4. The condensate treatment tube is rated for capacities up to 1000 MBH. The tank and combo tank/trap are each rated for 8000 MBH total. The boiler must be on a housekeeping pad to use the combination tank/trap option. Multiple boiler condensate drains can be combined into one tank (or tank/trap) as long as they do not exceed the rated capacity.

Condensate neutralization kit combination tank and trap

5. If the system is piped primary only, consider providing the automatic isolation valves as a factory option. If by others, delete the below item.

2.04 CONTROLS

The Boiler shall include a Falcon Computerized Boiler Burner control which shall be an integrated, solid state digital micro-processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point. It shall be mounted at the front of the boiler panel for easy access and viewing.

Controller shall provide for both flame safeguard and boiler control through separate power supplied CPU’s (to meet NFPA) and shall perform the following functions:

Burner sequencing with safe start check, pre-purge, Electronic direct spark ignition and post purge. A UV scanner shall be used to prove combustion.

Flame Supervision. The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent fifteen lockouts. The control shall be connected to a touchscreen display interface that will display this information in clear English text descriptions.

Safety Shutdown with display of lockout or hold condition.

PID modulating control of the variable speed fan for firing capacity relative to load requirements; i.e. to meet supply water temperature set point.

Gas pressure supervision, high and low.

Combustion Air Proving Supervision.

High Air Pressure [back draft too high] Supervision.

The supply temperature and set-point temperature shall be displayed at all times on the touch screen display.
Controller shall be equipped with a touch screen display for setup, troubleshooting, and operational display, and shall include BACNET communication capability of this information.

Include the programming of circulating pump or isolation valve control and support the control of 2 heating demand loops.

All parameter input control set-points shall be factory pre-configured. Parameter settings are to be established to suit jobsite conditions -- settings are to be configured at the time of initial jobsite operation.

All controls to be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls and also located to prevent possible damage by water according to UL and CSA requirements.

Electrical power supply shall be 460/3/60.

When multiple boilers are to be installed together, a system integration control shall be provided to stage up to 8 boilers. The control shall include automatic selection of needed boilers based on energy demand, an adjustable outdoor reset schedule, domestic hot water priority, and a system digital display. The control shall stage and modulate the boilers utilizing firing rate threshold staging and parallel modulation to optimize condensing potential while minimizing energy wasting short cycling. This strategy takes full advantage of the inverse efficiency characteristic (lower fire rate, higher efficiency) of condensing boilers. The control shall monitor supply water temperature, return water temperature and shall communicate between boilers via RS-485 network wiring.

Boilers shall communicate with BACnet I/P to building management system.

The Protocol Translator solution can either come factory mounted in a NEMA 1 enclosure, or ship loose for installation in a boiler control panel. Select the option below that applies.
Protocol translator mounted in a NEMA 1 panel with power supply and terminals.
Protocol translator shipped loose for installation in boiler control panel with required power supply.

The boiler controls shall include provisions for outside air reset.

The boiler controls shall include provisions for sending signal to open/close automatic isolation valve.

2.05 ELECTRICAL POWER

Single-Point Field Power Connection: Factory-installed and wired electrical devices necessary shall provide a single-point field power connection to boiler. Separate power and control connections will not be allowed.

6. Electrical connection will be 460/3/60 for Single-Point Field Power Connection for CFC-E 3500-6000. Retain line item “1” if different voltage is required for 3500-6000 MBH only. Delete line 1 if not applicable.
House in NEMA 250, Type 1 enclosure.
Wiring shall be numbered and color coded to match wiring diagram.
Install factory wiring outside of an enclosure in a metal raceway or conduit.

7. Select disconnect option below if disconnect is to be provided with boiler. If by others, delete item below.
Field power interface shall be to non-fused disconnect switch.

VENTING

Exhaust Stack: Complete system, per UL 1738 for Category IV appliances, stainless steel, pipe, vent terminal, thimble, vent adapter, and sealant. Stack to be designed and manufactured by boiler manufacturer.

Combustion-Air Intake: Complete system, PVC, galvanized steel or spiral duct pipe, vent terminal with screen, inlet air coupling, and sealant, by others.

PART 3 EXECUTION

3.01 Manufacturer's representative to supervise installation of burner and controls and to make all necessary adjustments to insure proper performance of the equipment.

3.02 Install boilers on new concrete pads.

3.03 Extend relief valve discharge pipe full size to 6" above floor, not to floor drain.

3.04 Boilers and burner controls furnished shall be set and wired by the HVAC Contractor. Power wiring by the Electrical Contractor.

3.05 Gas regulators shall be vented to outdoors.

3.06 Pipe boilers as recommended by the boiler manufacturer.

3.07 Boiler shall be provided with a condensate drain routed to the nearest floor drain. The boiler manufacturer shall provide an inline condensate drain neutralizer with the boiler for installation with the units.

3.08 Primary Boiler circulator pumps shall be selected and provided by the boiler manufacturer as a boiler system, the boiler system shall be provided with controls to modulate speed the boiler circulator pumps.

3.08 TESTS

A. The boiler manufacturer representative shall adjust and start-up boilers. Copies of the start-up report shall be sent to the Owner's Representative prior to final inspection and shall include full information for each boiler.

B. Boiler start-up requires the commissioning of the complete system under operating conditions.

C. Complete component and integrated check shall be made of all controls. Factory tests do not substitute for this test. A foreman or superintendent of the installing HVAC Contractor, familiar with the system, shall also be present and coordinate this test.

END OF SECTION
PART 1 GENERAL

1.01 REFERENCES

A. Drawings and general provisions of the Contract, including General and Supplementary conditions and Divisions 01 Specifications Sections, apply to this Section.

B. NFPA 70 - National Electrical Code.


D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

1.02 SUBMITTALS

A. Submit under provisions of division.

B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; nameplate legends add the following product data.

1. Complete wiring diagrams. Wiring diagrams to include components within the speed controller enclosure.

2. Overall system efficiencies at 1/4, 1/2, 3/4 and full motor load, including the effect of line reactors.

3. Complete handling, installation, wiring, troubleshooting and maintenance instructions. To include full schematic diagrams for all printed circuit boards. Also to include complete parts and component listing for all printed circuit boards and factory service manuals.

4. Actual calculated nameplate ratings for both input and output currents reflecting specific installation.

5. Displacement and distortion power factors.

1.03 OPERATION AND MAINTENANCE DATA

A. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.

B. Maintenance Data: Include routine preventive maintenance schedule.

1.04 REGULATORY REQUIREMENTS

A. Conform to requirements of NFPA 70.

B. Furnish products listed and classified by Underwriters' Laboratories, Inc.
1.05 DELIVERY, STORAGE AND HANDLING

A. Deliver, store, protect and handle product to site under provisions of division.

B. Accept controllers on site in original packing. Inspect for damage.

C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

D. Handle in accordance with manufacturer's written instruction. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to components, enclosure and finish.

1.06 MAINTENANCE SERVICE

A. Furnish service and maintenance of controller for one year from Date of Contract Completion.

1.07 SCOPE

A. Provide Yaskawa Solid State variable frequency controllers to control heating water pumps.

B. Units serving the heating water pumps are not required to be supplied with manual bypass.

C. All units provided for this project shall be on the same type and manufacturer.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

A. Furnish and install Yaskawa solid state variable frequency drives to vary the speed of the indicated 460 volt, 3 phase induction motors. System shall be microprocessor based, fully transistorized with a conservatively rated 3 phase, full wave diode bridge input and a PWM sine-coded output waveform. The input diode bridge will offer complete immunity against voltage dips, line noise and harmonics. The output transistors must be of the IGBT type (Insulated Gate Bipolar Transistor) to facilitate noiseless motor operation. The VFD's will be tested and rated for a minimum of 28 years Mean Time Between Failure (MTBF).

B. The speed controller inverter to be suitable for motors driving fans and pumps. Rectifier to be full wave type. Displacement power factor to be 0.98 minimum. Maximum total harmonic distortion (THD) to be limited to 5 percent.

C. Input power is from a 460 volt, 3 phase, 4 wire, 60 Hz distribution system. Output power to the motor at 60 Hz to be nominally 460 volts.

D. Controller to be designed for continuous operation at any speed (frequency) within the specified frequency range. Controller design to be such that openings of motor leads and operation of protective features do not cause component failures. Linear speed control to be from 10 to 100 percent of maximum speed, unaffected by input voltage changes of plus or minus 10 percent rated voltage.
E. Controller to operate satisfactorily in ambient temperatures from 32°F to 104°F (0°C to 40°C). Controller to be equipped with mechanical means for cooling components and to handle operating in a dirty environment.

F. Output frequency to remain stable (at its operating point) in spite of input voltage, input frequency and temperature variations within the specified ranges.

G. Controller to provide for "soft" start, with adjustable starting frequency.

H. Provide the following features:

1. Frequency range 6 to 60 Hz output to the motor, in proportion to 0-10 volt DC or 4-20 mA signal input to the controller.

2. Self-contained unit in a NEMA 1 enclosure with gasketed doors and clear vision panel in each door to display LED indicators, circuit breaker

3. Interfacing devices integral with the controller and connected.

4. Adjustable devices to positively limit the lower frequency (range 6 to 8 Hz minimum) and upper frequency (range 50 to 60 Hz minimum).

5. All Pilot lights to be LED type

6. Internal switches for "operate-service" select, output volts/hertz ratio, coast or ramp to start, and set point operation.

7. Provide LED indicator for ground fault indication.

I. Additional features:

1. Analog output signal: A voltage from 0 to 10 volt D.C., proportional to either output Hz, output voltage, or output amps.

2. LED status indicators for power on, enable trip, and LED's to indicate supplies are operating properly.

3. Auxiliary contacts with single pole, double throw contacts each rates 1 ampere at 115 volt AC for run indication, fault indication.

4. Provide input DC choke or line reactors.

J. Protective and miscellaneous features, to include:

1. Integral fuses as required to protect DC bus.

2. Power surge and spike protection (MOV's).

3. Output current limiting, without tripping by momentary overloads.

4. Instantaneous overcurrent tripping on phase to phase short circuits, high overloads and ground faults.
5. Undervoltage tripping on power or phase loss.

6. Overvoltage tripping.

7. Overtemperature tripping.


10. Speed indicator.

11. Input molded case, thermal magnetic circuit breaker with through door interlock, lockable in open position.

12. DC injection breaking before start.


14. Integral motor overload protection for the three legs, manually resetting bimetallic or eutectic alloy design, heaters sized for the motor.

15. A spare set of three fuses of each type and ampere rating.

16. Sets of dry form C contacts, actuated whenever the controller is operating the motor; refer to control CM drawings for quantities, and use.

17. Compliance with IEEE 519 latest issue; provide filtering necessary to abate electrical noise.

18. Field adjustment devices for current limit, motor overload, acceleration rate, deceleration rate, maximum speed, minimum speed, speed input and offset gain.

19. Remote start/stop input terminals used to start the drive from the DDC system shall also be common to all drives provided on this project. Provide quantity of drives shown on the drawings.

20. DDC interface to allow the VFD to communicate all points to Building Automation System. Coordinate requirements with the (Temperature Control) CM.

2.03 NAMEPLATES

A. Provide nameplates on all devices specified in this section.

B. Nameplates to match those used on existing equipment in Phase 1.

2.04 Variable Frequency Drives by Yaskawa, ABB, or Allen Bradley of the same type, size, capacity and meeting other specified requirements may be furnished at the CM’s option.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that surface is suitable for controller installation.
3.02 INSTALLATION
A. Install controller where indicated, in accordance with manufacturer's written instructions and NEMA ICS 3.1.
B. Tighten accessible connections and mechanical fasteners after placing controller.
C. Provide neatly typed label inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

3.03 FIELD QUALITY CONTROL
A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.

3.04 ADJUSTING
A. Make final adjustments to installed drive to assure proper operation of fan system. Obtain performance requirements from installer of driven loads.

3.05 CLEANING
A. Touch up scratched or marred surfaces to match original finish.

3.06 DEMONSTRATION
A. Demonstrate operation of controllers in automatic and manual modes.

3.07 FIELD TESTS
A. Check control and interlocking wiring for proper operation, in the presence of the CM, Miami University and the Construction Manager.

3.08 START-UP AND TRAINING
A. Manufacturer shall provide one (1) day for each building for start-up and training for the VFDs.

3.09 WIRING
A. Each unit to be complete with all interconnecting wiring and connections between components within unit and to terminal board for connection to remote devices. Each wire to have an identifying number at each end.

B. Terminal Board: Each unit to be provided with terminal boards completely accessible from the front by which line, load, and control connections for unit may be made and disconnected. Each terminal board to have all terminals clearly marked and all wiring between terminals to be provided, including connections to all extra and unused terminals on auxiliary contacts, relays, and control devices, etc.

3.10 TESTING AND START-UP
A. Upon completion of installation, including piping and electrical connections, each component of each speed control device and its driven fans to be inspected, tested, adjusted, programmed, etc. and placed in operation by a factory trained service technician employed by the VFD manufacturer. Manufacturer to provide competent, well-trained supervisor to instruct the Construction Manager’s operating personnel in the proper maintenance and care of the equipment. Instruction period, exclusive of
installation and start-up time, to consist of one two-hour period for all equipment specified in this section of specification.

END OF SECTION 23 90 13
SECTION 23 95 00
HVAC ALTERNATES

PART 1 GENERAL

1.01 REFERENCE

<table>
<thead>
<tr>
<th>Section #</th>
<th>Section Name</th>
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<tbody>
<tr>
<td>A.</td>
<td>Section 23 01 05 – GENERAL PROVISIONS</td>
</tr>
<tr>
<td>B.</td>
<td>Other applicable sections associated with the alternate scope below.</td>
</tr>
</tbody>
</table>

1.02 SCOPE

A. Alternate H-1;
   1. Base Bid; Existing heating water pumps P-1, & P-2 to remain.
   2. Alternate: Bidders shall state the amount to be ADDED TO the Base Bid for furnishing and installing all additional Division 23 work. Alternate H-1 scope includes demolition of the existing heating water pumps P-1 & P-2 and associated piping back to a point for installation of new pump and appurtenances. New work includes providing new heating water pumps P-1 & P-2, piping, valving, electrical connection, controls connections. A new differential pressure sensor shall be installed in the existing piping system where shown on drawings. The differential pressure sensor will report to the siemens BAS and the BAS will send a signal to the VFD’s associated with the new pumps. Provide all associated appurtenances as noted in drawings and specifications. Equipment to be furnished and installed as part of the contractors work. Refer to drawings and specifications for details on new work.

PART 3 EXECUTION

3.01 The costs of all the Alternates indicated in 1.02 above shall include all miscellaneous items required for the completely installed and functional alternate items indicated – AND – all of these alternates shall be clearly indicated on the Contractors Bid Form, and bid for the work.

3.02 Alternate equipment shall meet all requirements, including space (and coordination to avoid conflicts with other work), and delivery requirements, as indicated on Drawings, specified in the Base Specifications, or required for proper installation.

3.03 The contractor shall coordinate the “layout” of all alternate work, prior to the start of the work, and again prior to rough-in, to avoid conflicts.

3.04 Any modification or changes of any description required from the base Drawings or Specifications, made necessary by the use of alternate equipment in lieu of the specified equipment indicated on the Base Drawings or Specifications, including work involving other trades, shall be the responsibility of this Contractor and the cost thereof shall be included in his Bid on this Alternate.

END OF SECTION
SECTION 25 00 00
TEMPERATURE CONTROLS

PART 1 GENERAL

1.01 RELATED DOCUMENTS
A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
B. Refer to Electrical Drawings for specific requirements as they relate to Control Diagrams.
C. HVAC
   23 01 05 - HVAC GENERAL PROVISIONS
   23 05 53 - TAGGING AND CODING
   23 05 93 - TESTS AND ADJUSTMENTS
   23 21 23.13 - INLINE PUMPS
   23 21 23.16 - END SUCTION PUMPS
   23 90 13 - ADJUSTABLE FREQUENCY DRIVES
   25 00 01 - SEQUENCE OF OPERATION FOR HVAC CONTROLS

   ELECTRICAL
   Division 26 Electrical Specifications

1.02 SUMMARY
A. Siemens, Inc. will be the basis of design for this project. This system shall be engineered, programmed, and installed by personnel trained by the manufacturer and regularly employed by the manufacturer's recognized, approved, certified, and authorized agent. The agent shall have complete responsibility for proper installation and operation including checkout, test, calibration, commissioning, and warranty of the equipment and the entire system. The system shall be installed in strict compliance with the specifications. Supplier shall have an in-place support facility within 150 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

   1. DDC controls by BCI, Building Control Integrators (Delta Controls) of the same type and meeting other requirements may be bid to the Construction Manager as an option.

B. This section includes equipment and configuration requirements for the HVAC controls system as follows:

   1. General: The control system shall consist of a high-speed, peer-to-peer network of DDC controllers and a web-based operator interface. A web server with a network interface card shall gather data from this system and generate web pages accessible through a conventional web browser on each PC connected to the network. Operators shall be able to perform all normal operator functions through the web browser interface.

   2. The system shall directly control HVAC equipment as specified in Section 23 09 93 - Sequence of Operations for HVAC Controls. Each zone controller shall provide occupied and unoccupied modes of operation by individual zone. Furnish energy conservation features such as optimal start and stop, night
setback, request-based logic, and demand level adjustment of setpoints as specified in the sequence.

3. Provide for future system expansion to include monitoring of occupant card access, fire alarm, and lighting control systems.

4. System shall use the Miami University RPMS system for BAS communication. This system shall fully integrate into the MU-Remote Powers Management System (RPS) systems for complete communication to the campus operator workstations or web servers and for communication between DDC panels and modules. I/O points, schedules, setpoints, trends and alarms as specified in Section 23 09 93 - Sequence of Operations for HVAC Controls shall be included as specified.

1.03 SCOPE

A. Install a new DDC temperature control system in the Culinary Support Center as shown on the Drawings and as specified herein. System shall communicate with the campus DDC control system. Failure to mention any specific item or device does not relieve the Temperature Control Contractor of the responsibility for installing such device or item in order to comply with the intent of the drawings or this Specification.

1. Install DDC controls for the HVAC systems and plumbing systems.

2. Install monitoring for the HVAC systems, plumbing systems and electrical systems.

3. This specification is a performance type specification. Detailed design, conduit routing, programming, graphics generation, etc., is the responsibility of the Temperature Control Contractor. The materials and equipment specified are set up as a standard, and the Base Bid must be submitted on this basis.

4. Temperature Control Contractor shall provide:

   a. Necessary conduit, wiring, enclosures, and panels, for all DDC temperature control equipment and devices. Installation shall comply with applicable local and national codes.

   b. All components and control devices necessary to provide a complete and operable DDC system as specified herein.

   c. All final electrical connections to each DDC panel. Connect to 120 VAC power provided by the Division 26 Contractor.

   d. Temperature Control Contractor shall be responsible for all electrical work associated with the temperature control system and as called for on the Drawings. This temperature control wiring shall be furnished and installed in accordance with the electrical requirements as specified in Division 26, the National Electric Code and all applicable local codes.

   e. Surge transient protection shall be incorporated in design of system to protect electrical components in all DDC Controllers, Application Specific Controllers and operator's workstations. Provide an external protection device listed under UL 1449 with maximum clamping voltage of 400 volts and surge current capability of 26,000 amps.
f. All 120V and low voltage electrical control wiring throughout the building shall be run in conduit in accordance with the Electrical requirements as specified in Division 26, the National Electric Code, and all applicable local codes.

g. All 24V power required for operation of the DDC system shall be by the Temperature Control Contractor.

h. Temperature Control Contractor shall provide programming modifications necessary to fine tune sequences during commissioning and through warranty period of systems at no additional cost to the University.

i. Control wiring for the fan coil units controls including wiring of the Viconics thermostat, door switches, window switches and control valves.

j. Convey to the Campus Telecommunications System.

k. The DDC control system shall communicate energy data to an energy dashboard in each building.

l. The temperature controls contractor shall provide new temperature, humidity, and pressure sensors for all 10 existing air handling units within the building.

5. HVAC Contractor or Plumbing Contractors provides:

a. All wells and openings required for water monitoring devices, flow switches and alarms.

b. All package unit control panels, including but not limited to boiler units, etc.

c. Installation of all control valves.

6. Electrical Contractor provides:

a. Power circuit near temperature control equipment and devices and final connections to those devices called for on the electrical drawings.

b. Additional 120 volt power circuits for power to terminal boxes as shown on Electrical Drawings. Any quantity of circuits required over and above those shown on electrical drawings shall be at the Temperature Control Contractors expense. Power wiring from transformers for these boxes and all control wiring shall be by the Temperature Control Contractor.

c. 120 volt, 20 amp breaker for each DDC Control Processor.

7. Programming:

a. This Contractor will be responsible for complete programming and checkout for the systems controlled. Control systems to perform according to the "Sequence of Operation" in this specification.

b. All sensors provided shall be dynamically updated.
c. Temperature Control Contractor shall provide programming modifications necessary to fine tune sequences during commissioning of systems at no additional cost to Miami University.

B. General Architecture of the Temperature Control System:

1. The system shall incorporate Direct Digital Control (DDC), equipment monitoring, and control consisting of a PC based Operator Work Station (OWS) with color graphic data displays; microcomputer based DDC Control Processors (DDCs) interfacing directly with sensors, actuators and environmental delivery systems (i.e., HVAC units, pumps, etc.); electronic and electric controls and mechanical devices for all items indicated on drawings described herein including dampers, valves, panels, and devices; a primary communication network to allow data exchange from DDC to DDC control processors; microcomputer based Terminal Equipment Controllers (TECs) interfacing with sensors, actuators, and terminal equipment control devices; and a secondary communication networks interfacing TECs to DDC network devices.

2. The quantity and location of temperature control panels and devices shown on the drawings are for coordination purposes only, and in no way indicate the extent of the equipment. Additional panels or devices required to accomplish the sequence of operations outlined in this specification shall be the responsibility of the Temperature Control Contractor. This includes any electrical power wiring or additional circuits over and above that shown on the electrical contract drawings.

3. The system shall be modular in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC control processors, TEC’s, and operator devices.

4. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC control processor shall operate independently by performing its own specified control, alarm management, operator I/O and data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

5. DDC control processors shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC control processor or combination of controllers on the network without dependence upon a central processing device. DDC control processors shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

1.04 QUALITY ASSURANCE

A. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of Building Automation Systems and shall be manufacturer’s latest standard design that complies with the specification requirements.

B. The installer shall be employees of the temperature control system manufacturer or shall be recognized as an approved installer of temperature control system for the manufacturer.
C. Install system using competent workmen who are fully trained in the installation of temperature control equipment.

D. Single source responsibility of supplier shall be the complete installation and proper operation of the DDC temperature control system and shall include debugging and proper calibration of each component in the entire system.

E. Supplier shall have an in-place support facility at bid day within 50 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

F. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

G. The system shall comply with NFPA 90A Air Conditioning and 90B Warm Air Heating, Air conditioning. System shall be designed and manufactured to ISO 99001 quality standard, and all electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

H. Design and build all system components to be fault-tolerant.
   1. Satisfactory operation without damage at 110% and 85% of rated voltage and at plus 3 Hertz variation in line frequency.
   2. Static, transient and short-circuit protection on all inputs and outputs.
   3. Protect communication lines against incorrect wiring, static transients and induced magnetic interference.
   4. Network-connected devices to be A.C. coupled or equivalent so that any single device failure will not disrupt or halt network communication.
   5. All real time clocks and data file RAM to be battery-backed for a minimum 72 hours and include local and system low battery indication.
   6. All programs shall retain their memory for a minimum of 7 days upon loss of power.

1.05 SUBMITTALS

A. Submit three (3) complete sets of drawings showing the kind of control equipment for each of the various systems and their functions, along with indications on the drawing of all original setpoints and calibration values, and setup parameters, and sequence of operation of the DDC system. These drawings shall be submitted for approval to the Construction Manager, together with a complete brochure describing the equipment and their functions and operation. Include all application software documentation (actual programs or their job-specific flow charts) with DDC system and schedule a review meeting with the Construction Manager at least two weeks before installation and start-up.

   1. Manufacturer’s Product Data:
      a. All equipment components
2. Shop Drawings:
   a. System wiring diagrams with sequence of operation for each system as specified.
   b. Submit manufacturer’s product information on all hardware items along with descriptive literature for all software programs to show compliance with specifications.
   c. System configuration diagram showing all panel types and locations as well as communications network and workstations.
   d. System architecture diagram and descriptions.
   e. Approved room numbers are required to be included on all temperature control submittals, and all control as-built drawings.

B. Where installation procedures, or any part thereof, are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Construction Manager prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received.

1.06 COMMISSIONING

A. Provide necessary personnel as required to assist the Engineer, & Miami University in providing complete system operational testing.

PART 2 PRODUCTS

2.01 DDC CONTROL PROCESSORS PANEL

A. DDC Control Processors Panel shall be 16 bit microprocessor based with EPROM operating system. DDC programs and data files shall be non-volatile EEPROM or flash memory to allow simple and reliable additions and changes. Each DDC control processor shall have an on-board 30 day battery backed real time clock. DDC control processor shall be provided where shown or specified with capacity to accommodate input/output (I/O) points required for the application plus spare points specified. Each panel shall be provided with a socket for a Portable Operators Terminal (POT), and a port for network communications at no less than 78,000 baud. DDC outputs shall be binary for On-Off control, and true variable voltage (0-10v) for driving analog or pneumatic transducer devices. Analog outputs shall have a minimum incremental resolution of one percent of the operating range of the controlled device. DDC control processor shall have LEDs for continuous indication of all bus communications, power, and operational status. All panel electronics and associated equipment shall be installed in suitable enclosures.

1. Each DDC control processor shall have sufficient memory, a minimum of 1 megabyte, to support its own operating system and databases, including:
   a. Control processes
   b. Energy management applications
c. Alarm management applications including custom alarm messages for each level alarm for each point in the system.

d. Historical/trend data for points specified

e. Maintenance support applications

f. Custom processes

g. Operator I/O

h. Dial-up communications

i. Manual override monitoring

2. Each DDC control processor shall support:

a. Monitoring of the following types of inputs.

   Analog inputs
   1) 4-20 mA
   2) 0-10 Vdc
   3) Thermistors
   4) 1000 ohm RTDs

   Digital inputs
   1) Dry contact closure
   2) Pulse Accumulator
   3) Voltage Sensing

b. Direct control of electronic actuators and control devices. Each DDC control processor shall be capable of providing the following control outputs.

   Digital outputs (contact closure)
   1) Contact closure (motor starters, sizes 1-4)

   Analog outputs
   1) 0-20 psi
   2) 4-20 mA
   3) 0-10 Vdc

3. Each DDC control processor shall have a minimum of 10 percent spare capacity for future point connection. The type of spares shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than two spares of each implemented I/O type. Provide all processors, power supplies and communication controllers complete so that the implementation of a point only requires the addition of the appropriate point input/output termination module and wiring.

a. Provide sufficient internal memory for the specified control sequences and have at least 25% of the memory available for future use.

4. DDC control processor shall provide at least two serial data communication ports for operation of operator I/O devices such as industry standard printers, operator
terminals, modems and portable laptop operator's terminals. DDC control processor shall allow temporary use of portable devices without interrupting the normal operation of permanently connected modems, printers or terminals.

5. Each DDC control processor shall continuously perform self-diagnostics, communication diagnosis and diagnosis of all panel components. The DDC control processor shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication.

6. Isolation shall be provided at all peer-to-peer network termination's, as well as all field point termination's to suppress induced voltage transients consistent with IEEE Standards 587-1980.

7. The operator shall have the ability to manually override automatic or centrally executed commands at the DDC Controller via local, point discrete, on-board hand/off/auto operator override switches for digital control type points and gradual switches for analog control type points. These override switches shall be operable whether the panel processor is operational or not.

   a. Switches shall be mounted either within the DDC Controllers key-accessed enclosure, or externally mounted with each switch keyed to prevent unauthorized overrides.

   b. DDC Controllers shall monitor the status of all overrides and inform the operator that automatic control has been inhibited. DDC Controllers shall also collect override activity information for reports.

8. In the event of the loss of normal power, there shall be an orderly shutdown of all DDC Controllers to prevent the loss of database or operating system software. Programs residing in memory shall be protected either by using EEPROM or by an uninterruptible power source (battery backup). The backup power source shall have sufficient capacity to maintain volatile memory in event of an AC power failure. Where uninterruptible power source is rechargeable (a rechargeable battery), provide sufficient capacity for a minimum of seventy-two hours backup. Charging circuitry, while the controller is operating under normal line power, shall constantly charge the rechargeable power source. A non-rechargeable power source shall not be permitted. Batteries shall be implemented to allow replacement without soldering.

   a. Upon restoration of normal power, the DDC Controller shall automatically resume full operation without manual intervention.

9. Provide a separate DDC control processor for each AHU and other HVAC systems as required. It is intended that each unique system be provided with its own point resident DDC control processor.

10. Control strategies that separate the function of the above DDC control processor controller into multiple controller (i.e. control process controller and communications) shall be acceptable provided that all requirements specified are fully met. This includes but is not limited to:

   a. Spare Point Capacity
   b. Spare Internal Memory
   c. Serial Communication Ports
d. A separate PCP per Unique System

2.02 TERMINAL EQUIPMENT CONTROLLER (TEC)

A. Terminal Equipment Controller (TECs) shall be UL916 standalone EEPROM based configured to perform the sequences specified, and with I/O selected for the application. TEC enclosures shall be compact plastic conforming to UL94-5V or plated steel. Each TEC shall be provided with LED type annunciation to continually display its operational mode; power, normal, or in an alarm state. 9600 baud TEC networks shall be grouped with no more than 20 TECs per primary bus connected device.

1. Provide for control of each piece of equipment, including, but not limited to, the following:
   a. Variable Air Volume Terminal Boxes
   b. Fan Coil Units with sensors (non-Viconic)
   c. Cabinet Unit Heaters with sensors (non-Viconic)

2. TECs shall include all point inputs and outputs necessary to perform the specified control sequences. As a minimum, 50% of the point outputs shall be of the Universal type; that is, the outputs may be utilized either as modulating or two-state, allowing for additional system flexibility. Analog outputs shall be industry standard signals such as 24V floating control, allowing for interface to a variety of modulating actuators. Terminal equipment controllers utilizing proprietary control signals and actuators shall not be acceptable. TECs utilized for the control of VAV or CV boxes with fin radiation shall be able to accept a minimum of (2) independent temp inputs and shall have (2) independent analog outputs to control the box and the finned radiation independently. As an alternate, provide (2) TECs.

3. Each TEC performing space temperature control shall be provided with a matching room temperature sensor. The sensor may be either RTD or thermistor type providing the following minimum performance requirements are met:
   - Accuracy: ± 1°F (±0.6°C)
   - Operating Range: 35° to 115°F (2° to 46°)
   - Set Point Adjustment Range: 55° to 95°F (2° to 30°C)
   - Set Point Modes: Independent Heating
   - Independent Cooling
   - Night Setback - Heating
   - Night Setback - Cooling
   - Calibration Adjustments: None required
   - Installation: Up to 100 ft. from Controller

   a. Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. Providing a portable operator's terminal is a part of this project. In lieu of an internal jack,
provide a separate terminal jack mounted on a stainless steel wall plate adjacent to the sensor to facilitate direct access to the controller via the terminal.

b. Room sensor temperature setpoint adjustment will not be provided.

c. Each temperature sensor shall be furnished with a blank cover (no thermometer).

4. Each TEC shall perform its primary control function independent of other controllers and if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the DDC control processor time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. All PID gains and biases shall be field-adjustable by the user via terminals as specified herein.

5. Provide each TEC with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Provide uninterruptible power supplies (UPSs) of sufficient capacities for all terminal controllers that do not meet this protection requirement. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of applications are not acceptable.

6. All box TEC applications shall be field-selectable such that a single controller may be used in conjunction with any type of terminal units to perform the specified sequences of control. This requirement must be met in order to allow for future design and application changes and to facilitate system expansions. Controllers that require factory application changes are not acceptable.

2.03 PCP SOFTWARE

A. Control Software:

1. Time Programs. Each DDC control processor shall contain up to 20 unique user modifiable time programs (TP). Each TP shall consist of daily, weekly, and annual programs plus a "TODAY" temporary function. DAILY programs shall be definable for day types such as working day, half day, holiday, weekend, etc. Each daily program shall allow a list of time based (or optimum time based) analog and digital commands to be issued to user selected plant elements and points. WEEKLY programs shall allow a user selected set of daily programs to be defined for each day of the week (Monday through Sunday). The ANNUAL program shall initially be an automatic compilation of 52 weekly programs. Selecting a date of the ANNUAL program shall allow modification of the daily selection entered into the weekly program (such as changing Dec. 25 from a working day to a holiday).

B. Management Software:
1. Trending. In addition to supporting OWS trending specified elsewhere, each DDC control processor shall be provided with a trend archive of at least the last 200 events (digital transitions or analog value changes) of any user selected group of up to 20 points. A stored event shall include date and time, and value or status. Events occurring in excess of 200 shall overwrite the oldest events.

2. Alarms. Each DDC control processor shall monitor and report all analog input points and specified digital points for off-normal conditions. Each alarm shall have an "alarm delay" attribute which shall determine how long (in seconds) a point must be off-normal prior to being considered in an alarm state.

3. TEC Support. DDC control processor and devices managing sub-networks of TECs shall report TEC alarms and shall be programmed to perform data reduction, sorting, and DDC control processor optimizing routines. In no case shall mass TEC optimizing data be allowed on the primary bus.

2.04 TEC SOFTWARE

A. TEC Software shall be configured to meet the requirements of the "Sequence of Operation" specified and shall be field reconfigurable. TEC software shall support full PID control, and shall utilize separate PID gains for heating and cooling. Where TEC space sensors are provided with temperature setpoint knobs, TECs shall be provided with unique software setpoint limits. Each TEC shall have continuously running hardware diagnostics to detect malfunctions of the flow sensor, the temperature sensor, the remote setpoint sensor, and the A to D converter.

B. TECs shall have preconfigured air flow calibration software to assist the test and balance (T&B) contractor in final calibrations. Using the TEC contractors calibration tool, provided by the BAS Contractor, the T&B contractor shall be provided with a display allowing a simple command entry to place the TEC in zero, minimum, and maximum CFM control modes. At each mode, a display field shall be provided for the T&B contractor to enter the actual measured value in CFM. Upon completion of entering the three values, the TEC shall automatically recalibrate based upon the actual values.

2.05 WEB-BASED WORKSTATION OPERATOR INTERFACE

A. Basic Interface Description

1. Operator workstation interface software shall minimize operator training through the use of English language prompting, English language point identification and industry standard PC application software. The software shall provide, as a minimum, the following functionality:

   a. Graphical viewing and control of environment
   b. Scheduling and override of building operations
   c. Collection and analysis of historical data
   d. Definition and construction of dynamic color graphic displays
   e. Editing, programming, storage and downloading of controller databases

2. Provide a graphical user interface which shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.
a. Provide functionality such that all operations can also be performed using the keyboard as a backup interface device.

b. Provide additional capability that allows at least 10 special function keys to perform often-used operations.

3. The software shall provide a multi-tasking type environment that allows the user to run several applications simultaneously. The mouse shall be used to quickly select and switch between multiple applications. This shall be accomplished through the use of Microsoft Windows© or similar industry standard software that supports concurrent viewing and controlling of systems operations.

   a. Provide functionality such that any of the following may be performed simultaneously, and in any combination, via user-sized windows:

      1) Dynamic color graphics and graphic control
      2) Alarm management.
      3) Time-of-day scheduling
      4) Trend data definition and presentation
      5) Graphic definition
      6) Graphic construction

   b. If the software is unable to display several different types of displays at the same time, the DDC Contractor shall provide at least two operator workstations.

4. Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display and data base manipulation capabilities as he deems appropriate for each user, based upon an assigned password.

   a. A minimum of five levels of access shall be supported:

      1) Level 1 - View all applications, but perform no database modifications
      2) Level 2 = Custodial privileges plus the ability to acknowledge alarms
      3) Level 3 = All privileges except system configuration
      4) Level 4 = All configuration privileges except passwords
      5) Level 5 = All privileges

   b. A minimum of 50 unique passwords, including user initials, shall be supported.
c. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.

d. The system shall automatically generate a report of log-on/log-off time and system activity for each user.

e. User-definable, automatic log-off timers of from 5 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

5. Software shall allow the operator to perform commands including, but not limited to, the following:

a. Start-up or shutdown selected equipment
b. Adjust setpoints
c. Add/modify/delete time programming
d. Enable/disable process execution
e. Lock/unlock alarm reporting for points
f. Enable/disable totalization for points
g. Enable/disable trending for points
h. Override PID loop setpoints
i. Enter temporary override schedules
j. Define holiday schedules
k. Change time/date
l. Automatic daylight savings time adjustments
m. Enter/modify analog alarm limits
n. Enter/modify analog warning limits
o. View limits
p. Enable/disable demand limiting for each meter
q. Enable/disable duty cycle for each load

6. Reports shall be generated and directed to either CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:

a. A general listing of all points in the network
b. List of all points currently in alarm
c. List of all points currently in override status
d. List of all disabled points
e. List of all points currently locked out
f. DDC Controller trend overflow warning
g. List all weekly schedules
h. List of holiday programming
i. List of limits and deadbands

1) Summaries shall be provided for specific points, for a logical point group, for a user-selected group or groups or for the entire facility without restriction due to the hardware configuration of the building automation system. Under no conditions shall the operator need to specify the address of the hardware controller to obtain system information.

B. Scheduling
1. Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide the following spreadsheet graphic types as a minimum:
   a. Weekly schedules
   b. Zone schedules
   c. Monthly calendars

2. Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Each schedule shall include columns for each day of the week as well as holiday and special day columns for alternate scheduling on user-defined days. Equipment scheduling shall be accomplished by simply inserting occupancy and vacancy times into appropriate information blocks on the graphic. In addition, temporary overrides and associated times may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.

3. Zone schedules shall be provided for each building zone as previously described. Each schedule shall include all commandable points residing within the zone. Each point may have a unique schedule of operation relative to the zone’s occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and rescheduling of points may be accomplished easily via the zone schedule graphic.

4. Monthly calendars for a 24-month period shall be provided which allow for simplified scheduling of holidays and special days in advance. Holidays and special days shall be user-selected with the point device and shall automatically reschedule equipment operation as previously defined on the weekly schedules.

C. Collection and Analysis of Historical Data

1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data may be stored on hard disk for future diagnostics and reporting.

2. Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 6 points. Provide additional functionality to allow any trended data to be transferred easily to an off-the-shelf spreadsheet package such as Microsoft Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.

3. Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both static and/or real-time dynamic point data. A minimum of 4 points may be viewed simultaneously on a single graph, with color selection and line type for each point being user-definable. Displays shall include an 'X' axis indicating elapsed time and a 'Y' axis indicating a range scale in engineering units for each point. The 'Y' axis shall have the ability to be manually or automatically scaled at the user’s option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the ‘Y’ axis. All ‘Y’ axis data shall be color-coded to match the line color for the corresponding point.
a. Static graphs shall represent actual point data that has been trended and stored on disk. Exact point values may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a building management and diagnostics tool.

b. Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take “snapshots” of screens to be stored on the workstation disk for future recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.

D. Dynamic Color Graphic Displays

1. Color graphic floor plan displays and system schematics for each piece of mechanical equipment, including air handling units, chilled water system and hot water heating system, shall be provided by the DDC Contractor to optimize system performance analysis and speed alarm recognition.

2. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.

3. Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.

4. The windowing environment of the PC operator workstation shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

5. Graphic generation software shall be provided to allow the user to add, modify or delete system graphic displays.

a. The DDC Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.

b. The graphic development package shall use a mouse or similar pointing device in conjunction with a drawing program to allow the user to perform the following:

1) Define symbols
2) Position and size symbols
3) Define background screens
4) Define connecting lines and curves
5) Locate, orient and size descriptive text
6) Define and display colors for all elements
7) Establish correlation between symbols or text and associated system points or other displays

c. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout or any other logical grouping of points which aids the operator in the analysis of the facility.

1) To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC controllers including TECS used for DDC equipment or VAV terminal unit control.

6. General graphics software shall have the capacity to trend a minimum of 200 points of the DDC control system simultaneously.

2.06 SOFTWARE, PROGRAMMING AND COMMISSIONING

A. Provide hard copies of all programs when the Miami University Representative has signed off as complete.

2.07 FIELD DEVICES

A. All devices and equipment shall be approved for installation.

B. All analog inputs and outputs to/from all items, relating to the monitoring and control of variable speed drives shall be 4-20 MA DC devices, loop-powered, isolated, allowing any single sensor to report identically to multiple systems.

C. Electric Thermostats

1. Locking cover, snap acting, 120 volt, 10 amp. Thermostats to be arranged for wall mounting with external adjustment and without thermometer.

D. Temperature Sensors: Each temperature sensor shall match the requirements of the associated temperature controller. Each sensor shall be designed for the appropriate application (i.e. duct, immersion, etc.) and be provided with all necessary installation accessories. Ranges shall be selected to the middle of the control range. All space temperature sensors not provided with an associated application specific controller shall match the sensors furnished with application specific controllers. All Temperature sensors in lobbies or vestibules shall be capable of proper operation at temperatures 40ºF or lower than setpoint. Refer to Paragraph 2.02 A.3 for space temperature sensor requirements.

1. Electronic: A modulating solid state controller with built-in detector, P, PI, or PID controller, as required, with continuous voltage or current output. Each controller shall have individual setpoint, proportional band, start point, and span adjustments. Input voltage shall be 24 VAC or less. Each controller to be provided with night setback, summer/winter switchover or remote reset capabilities as required. Controllers shall be of matching type to the input detectors and output drives or sequencers.

2. All room sensors in public areas shall have concealed setpoint adjustments and shall be provided with a Uni-guard Inc. model UG-2A (almond) sensor guard. Similar guards may be provided at the contractor's option but must be submitted
for approval by Miami University, the Architect and the Engineer before procuring.

3. Humidity Sensors: The relative humidity transmitter monitors and transmits changes in humidity, accurate to ±2% RH. Operating range shall be 0 to 99% RH.

4. Install thermostats and sensors at 4'-0" AFF to bottom unless otherwise noted on Architectural Drawings. Coordinate installation with the work of other trades before any rough-ins are made.

5. Duct Sensors: DDC duct sensors shall match the requirements of the associated controller incorporating an electrical signal to insure exact and proportional relationship between the measured variable and the transmitted signal. Where a device is used for sensing of Mixed Air Temperature or Preheat applications and the duct area is in excess of 24 square feet the instrument shall incorporate a capillary averaging element with a minimum length of 96 inches or a suitable array of duct sensors wired as a single input. Averaging sensors shall be used on any duct application where duct area exceeds 24 square feet.

   a. Duct temperature sensors shall have a digital display on the front of the sensor which shall display the temperature in degrees F., a hinged ABS weatherproof enclosure and stainless steel probe. Grey stone TE512 series or equal.

   b. Power for temperature sensors provided by the Temperature Control Contractor.

6. All hot and chilled water temperature sensors in piping systems shall be provided with a separable stainless steel thermowell to be installed by the HVAC Contractor, but furnished by the Temperature Control Contractor. Chilled water supply and return temperature sensors shall have an accuracy of +1/4°F. All sensors shall have a digital temperature display.

   a. Pipe temperature sensors shall have a digital display on the front of the sensor which shall display the temperature in degrees F. a hinged ABS weatherproof enclosure, stainless steel probe and ½" NPT fitting. Greystone TE 512 series or equal.

   b. Power for temperature sensors provided by the Temperature Control Contractor.

7. Outside air sensors shall be accurate within 0.5°F over a range of -50°F to 120°F. Special care must be taken to place sensor away from building exhausts. Outside sensors shall be watertight and must have sun shielding.

8. Provide temperature sensors as required to meet the sequence of operation; in addition, provide temperature sensors in the following locations: return air, mixed air and discharge air sections if not required by the sequence of operation.

E. Indicating Thermometers

1. Thermometers shall be of the dial type, minimum 3-1/2" diameter, duct mounted, bimetal element, uniform scale of suitable range. Accuracy: plus or minus 1-1/2% of total range of thermometer.
2. Thermometers can be omitted when the temperature sensor digital read out is visible from the floor.

F. Pressure Sensors: Duct static pressure analog sensors shall be high accuracy +/-1% of range suitable for the low pressures and selected for at least 50% over range. Sensors shall have industry standard 4-20 mA output and zero end span adjustments.

G. Electronic damper motors for terminal boxes will be provided by the temperature control contractor and shipped to the terminal box manufacturer for mounting. Mounting charges shall be the responsibility of the terminal box manufacturer.

1. VAV Terminal Boxes using internal actuators are unacceptable.

H. Automatic Control Valves (Throttling Plugs): General Design - All valves shall be equipped with throttling plugs and removable composition discs. All valves are to be sized by the Control Contractor and shall submit pressure drop calculations and guarantee sufficient size to meet the requirements of the equipment being served. Valve operators shall be of such design so as to provide adequate operating power for valve positioning. All valves are to be equipped with U-cup silicone packing.

1. Reheat valves controlled by Application Specific Controllers shall utilize electronic actuation. All reheat valves shall fail in last position. Valves to be characterized port ball valves, manual declutching, manual position lever.

2. Three-way Valves: Three-way valves are to be of the three port mixing arrangement, designed expressly for mixing of two inlets and providing a common outlet. The use of reverse piped diverting valves shall not be acceptable. The Temperature Control Contractor will be responsible to the HVAC Contractor to notify and provide guidance as to correct method of piping of all three-way valves.

3. Control valves for HVAC equipment shall utilize electronic activation. Butterfly valves for air handling unit coil control are unacceptable. If high GPM requirements dictate the valve size to be greater than 6", then Temperature Control Contractor shall provide two control valves for the application, and the HVAC Contractor shall install the two control valves, for parallel and/or sequenced operation.

4. For all fan systems with separate pre-heat and separate 2\textsuperscript{nd} heating coil. The pre-heat coil shall fail normally open, shall include separate analog output AO point for control, and separate analog input AI point for low-limit pre-heat discharge control. The separate 2\textsuperscript{nd} heating coil shall fail normally open, shall include separate analog output AO point, and separate analog input AI point for low-limit heating control.

5. For all fan systems with re-heat coil within the mechanical equipment room, the reheat coil valve shall fail in last position.

6. Control valves for 2-position applications shall be line sized.

I. Smoke Detectors - by Electrical Contractor
J. Air Static and Velocity Pressure Transmitter: The pressure transmitter shall be used for measuring duct static or velocity pressure in variable air volume fan systems.

K. Low Limit Detection Thermostat: Low limit detection thermostats shall be of the vapor tension capillary type having a sensing element a minimum of 20 feet in length. These thermostats shall be of the manual reset type. The elements shall be complete with necessary fittings to permit installation in the duct so as to sense the correct discharge temperatures. One low limit detection thermostat will be installed for every 24 square feet of protected area and arranged so as to stop their respective units and close the outside air dampers in the event discharge temperatures fall below 40 degrees F. The normally closed contact shall be wired to the fan circuit and the normally open contact (close on alarm) shall be wired to a DDC input. One common circuit is suitable for multiple thermostats on a single AHU coil area.

L. Fan and Pump Proofs: Proof points for air handling unit fans, exhaust fans and pumps will be accomplished through the use of current sensing relays at the motor control center or motor starters. Current sensing relays shall be split-core design, for installation over any single power lead. Current sensing relays shall include field adjustable set screw for amperage setpoint adjustment, and shall include integral LED status light to locally indicate the ‘on’ and ‘off’ condition.

M. Carbon Dioxide Sensors

1. Carbon dioxide sensors shall be wall mounted non-dispersive infrared transmitters. Sensors shall include a relay with N.O. and N.C. output contacts, either a 4-20 Ma or 0-10 VDC analog output, and angled display to indicate concentrations at the sensor.

   Sensors shall be capable of measuring levels from 0-2000 PPM with an accuracy of 75 PPM in an operating temperature range of 32°F to 122°F and a relative humidity of 0 to 99% non-condensing. Sensors shall operate on 24 volt AC 2.5 watt single phase power.

2.08 FILTER PRESSURE DROP INDICATION

A. Furnish and install differential pressure draft gauge across filter section of each air handling unit to indicate the total pressure drop through each prefilter and final filter section. Gauge shall be similar to Dwyer "Magnahelic" Series 2000. Range as required. Install gauges at unit a maximum 5'-0" above floor.

2.09 LABELING

A. Provide labels for all field devices including sensors, transducers, thermostats, and relays. Exception: Room temperature and/or humidity sensors shall not be labeled.

B. Labels shall be black laminated plastic with white letters and adhesive backing or screw fasteners. Labels shall be located adjacent to device and permanently affixed to device mounting surface. Do not install the label on the device. Labels for sensors in pipes may be secured using chain around the sensor well.

C. Labels shall include system virtual/pseudo point name as well as English language name of device being controlled or specific condition being sensed.

D. Identify all control wiring and pneumatic tubing at each end with a number.
E. All labeling shall be in accordance with Miami University labeling standards.

PART 3 EXECUTION

3.01 WIRING AND CONDUIT

A. Refer to Section 23 05 13 for a description of the wiring responsibilities for the temperature control system by the Temperature Control Contractor and the Electrical Contractor. Also refer to the control diagrams on the Contract Drawings which further clarify wiring responsibilities.

B. All temperature control wiring shall be run in conduit. Refer to specification section 26 05 33 for conduit requirements. Conduit and junction boxes shall be labeled as being for the temperature control system.

C. All Class I wiring shall be copper, THHN, 14 gauge AWG with 600 volt minimum isolation class insulation. Power and Class I 120 volt control circuits may not run together with Class II or III data transmission or signal circuits. Where different wiring classes terminate per NEC requirements, all control system wiring shall be labeled with control system logical point name. These point names shall be exactly as shown on control drawings, digital controller, sensor, actuator device terminal connectors and on "As-Built" drawings exactly as installed.

D. The Temperature Control Contractor shall be responsible for making correct connections to all equipment, (i.e. motor starters) necessary to provide digital and analog input signals to the direct digital control system. The Temperature Control Contractor shall install all necessary interface devices, relays, isolators, to insure both proper operation of interfaced equipment and the digital control system. The Contractor shall be responsible for procuring engineering, technical information and field assistance from all other HVAC/electrical contractors and shall include this cost within their bid proposal.

E. All electrical work shall be done in strict accordance with the latest edition of the National Electric Code and all local codes. The Temperature Control Contractor shall be fully responsible for proposals and modifications necessary to meet any and all code required modifications.

F. All wires connected to control items shall be tagged with their logical point name.

G. All temperature control panels shall be completely prewired by the Temperature Control Contractor to terminal strips within the control cabinet. All internal interlock wiring within the control panel shall be complete to the terminal strips.

3.02 SPACE THERMOSTATS/SENSORS

A. Thermostats and room sensors shall be mounted at 48" above floor unless otherwise noted on Architectural elevations. Coordinate installation with the Architect/Engineer and work of other trades before any rough-ins are made.

3.03 TEMPERATURE CONTROL DIAGRAMS

A. Complete temperature control diagrams including motor control schematics, wiring diagrams and a written description of the system operation shall be provided by the Temperature Control Contractor. Diagrams shall include face elevations of the temperature control panels.
B. A set of floor plans shall be provided showing the location of all temperature control panels to be installed. Locations shall be approved by the Engineer. The floor plans to be submitted as an AutoCAD drawing file with blocks defined for all control equipment; panels, Terminal Equipment Controllers (TEC’s) and sensors, etc. The blocks should contain pertinent technical information such as panel numbers, node numbers and any other specific information about control system entities.

C. The Temperature Control Contractor shall provide submittals of all shop drawings for all work prior to start of project. Provide a complete written description of the system proposed. Start with a general overview of the product leading to specific and detailed sequences necessary to provide the highest level of operational efficiency. Show how proposed hardware and software meets specifications, especially in its ability to deliver accurate, reliable, trouble-free performance along with ease of operation.

D. Submittals shall include detailed schematicos of all systems and equipment controlled for the project, as well as diagrams detailing interconnection of all digital controllers and interfacing to existing temperature control networks and campus Ethernet data highway. Schematics to include all devices proposed for the project and shall incorporate industry standard HVAC and control symbols and naming conventions. Detailed wiring diagrams for all devices shall be provided as part of the submittal package. All schematics shall be prepared using the latest revision of AutoCAD or similar computer aided drafting software. Manual sketches or drafting techniques are not acceptable.

E. Furnish complete sets of Operating and Maintenance Instructions for temperature controls, including control diagrams, to the HVAC Contractor for inclusion in the “Operating and Maintenance Manuals”. As-built control drawings must show setpoints and spring ranges.

F. Provide Miami University with a copy of the control diagrams on computer disk.

3.04 CALIBRATION

A. Inasmuch as controllers are factory calibrated and controlled devices have nominal operating ranges, different from actual field conditions, all controllers shall be calibrated and set for the actual field conditions. (A listing of actual spring ranges on controlled devices, such as for valves, damper motors, etc., shall be submitted to the University’s Operating Engineer for future recalibration/maintenance.)

B. Miami University shall have the option to review the operation of up to 5% of the controllers furnished on the project. If the operation of the controllers is not acceptable to Miami University, they may require that the operation of the remainder of the controllers be reviewed.

3.05 SUPERVISION

A. All temperature controls shall be installed and calibrated under the supervision of a qualified representative of the Temperature Control Manufacturer.

3.06 CONTROL ACCESS

A. All control elements shall be placed in locations affording easy access for service. All devices remote from control panels shall be identified as specified for control items in control panels.
3.07 SYSTEM START-UP

A. After installation is complete, and during the warranty, the Temperature Control Contractor shall be responsible for commissioning, continued software de-bugging, software revisions and control loop tuning necessary to insure that control sequences are functioning as specified and that setpoints are being maintained without excessive cycling of actuators. To this end, the Temperature Control Contractor shall generate hard copy historical trend log data reports showing hourly readings of all important system points. Reports shall be delivered (or mailed) to the Engineer. The trend reports will document that each control loop is properly tuned and that all software functions are performing as specified.

B. All initial application software shall be programmed by the Temperature Control Contractor. (Miami University shall be provided with copies of the source program and all documentation necessary for them to interpret it and make any changes they desire.)

1. The Temperature Control Contractor shall initiate the audit log for each building at the direction of Miami University.

3.08 WARRANTY

A. All components, system software and devices supplied by the Temperature Control Contractor shall be guaranteed against defects in material and workmanship for one year from final acceptance date. (The acceptance date is defined when the total system is demonstrated to Miami University to be complete and when all hardware, sensors, controllers, and software are functioning according to the sequence of operation specified for the project.) Punch list items shall not prevent final acceptance where the nature of the problem and resolution of the problem is underway by the Contractor.

B. Labor to trouble shoot, repair, re-program, or replace any component shall be furnished by the Temperature Control Contractor at no charge to Miami University during the warranty period.

C. All corrective modifications made during warranty service shall be updated and saved on master archive software disks to be kept in for safe keeping. The Temperature Control Contractor shall keep an identical copy in their local office during the warranty period.

3.09 QUALITY ASSURANCE

A. All system components shall be designed and built for fault tolerance, shall operate satisfactory at 110% above and 85% below rated voltage. Static and transient, and short circuit protection shall be on all inputs and outputs. The system shall be protected against incorrect wiring, static and lighting induced transients and magnetic interference. Data transmission trunk connected devices, (i.e., digital controllers, etc.) shall be AC coupled or be optically isolated so that a single device failure will not damage or disrupt or halt trunk communications between other digital controllers, unitary or terminal controllers.

B. All electrical equipment shall conform to the F.C.C. regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

C. The system shall be installed by factory trained technicians and mechanics regularly employed by the temperature control manufacturer whose principal business is the manufacturing and installation of direct digital control systems.
3.10 DOCUMENTATION

A. Upon completion of the system, the Temperature Control Contractor shall deliver complete documentation pertaining to the system installed. Include as-built record drawings, control system wiring diagrams, schematics, layouts, input/output point lists, complete program listings for each controller and a complete building operators manual and system engineering and programmers manual. The manual shall cover all functions, descriptions, routines necessary to both modify system software, add points and to completely maintain the system hardware and software.

3.11 SYSTEM ACCESS

A. System Access (Passwords) shall be provided at the start of beneficial occupancy or near project completion to allow Miami University the time necessary to inspect the system and to provide an accurate and timely Punch List to speed project completion.

3.12 CONTROL CONTRACTOR REMOTE MONITORING

A. The Temperature Control Contractor shall provide an on-line remote monitoring of the project for software and hardware problems during initial system start up and for at least two months following system completion. This assistance shall be performed during 8:00 a.m. to 5:00 p.m. Monday through Friday. A modem for communication to the Temperature Control Contractor's office shall be provided for this purpose. Provide the necessary software or firmware for its operation.

3.13 TECHNICAL SUPPORT

A. The Temperature Control Contractor shall provide as part of this contract technical support personnel available for immediate response during normal business hours, to provide emergency service on the system during the warranty period.

B. The Temperature Control Contractor shall submit to Miami University the cost per hour for emergency service after normal 8:00 a.m. to 5:00 p.m., Monday through Friday for work necessary during the warranty period.

3.14 TRAINING

A. The Contractor shall provide competent instructions to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 7:00 a.m. to 3:30 p.m. weekdays as follows:

B. Provide 40 hours of training for Miami University's operating personnel. Training shall include:

1. Explanation of drawings, operations and maintenance manuals
2. Walk-through of the job to locate control components
3. Operator workstation and peripherals
4. DDC controller and TEC operation/function
5. Operator control functions including graphic generation and field panel programming

6. Operation of portable operator’s terminal

7. Explanation of adjustment, calibration and replacement procedures

C. Provide 8 hours of additional training quarterly for a period of one year from final completion of the project.

D. Since Miami University may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If Miami University requires such training, it will be contracted at a later date. Provide description of available local and factory customer training.

3.15 SERVICE AND GUARANTEE

A. General Requirements: Provide all services, materials and equipment necessary for the successful operation of the entire DDC system for a period of one year after completion of successful performance test. Provide necessary material required for the work. Minimize impacts on facility operations when performing scheduled adjustments and non-scheduled work.

B. Description of Work: The adjustment and repair of the system includes all computer equipment, software updates, transmission equipment and all sensors and control devices. Provide the manufacturer’s required adjustments and all other work necessary.

C. Personnel: Provide qualified personnel to accomplish all work promptly and satisfactorily. Miami University shall be advised in writing of the name of the designated service representative, and of any changes in personnel.

D. Systems Modifications: Provide any recommendations for system modification in writing to Miami University. Do not make any system modifications, including operating parameters and control settings, without prior approval of Miami University. Any modifications made to the system shall be incorporated into the operations and maintenance manuals, and other documentation affected.

E. Software: Provide all software updates and verify operation in the system. These updates shall be accomplished in a timely manner, fully coordinated with the system operators, and shall be incorporated into the operations and maintenance manuals, and software documentation.

END OF SECTION
PART 1 - GENERAL

1.01 RELATED DOCUMENTS

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

B. Refer to Electrical Drawings for specific requirements as they relate to Control Diagrams.

1.02 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

B. Related sections include the following:

1. Section 25 00 00 “Temperature Controls” for control equipment and devices, submittals, quality assurance, coordination and training requirements.

1.03 SCOPE

A. The control sequences as described below shall be incorporated in the DDC (Direct Digital Control) system operation.

B. The controls contractor shall confirm the system is fully functioning. Refer to 25 00 00 “Temperature Controls” for more detailed requirements.

PART 2 - PRODUCTS

Not Applicable.

PART 3 EXECUTION

3.01 DDC TEMPERATURE CONTROL SEQUENCES

A. New Heating Water Boiler System Control

1. The boiler system shall be enabled to run whenever the heating water loop pumps are operating.

2. Heating duties shall be from the two (2) new boilers arranged in an operating and standby configuration. The operating and standby boilers shall be capable of simultaneous operation during high heating demand periods.

3. To prevent short cycling, each boiler shall run for and be off for minimum adjustable times (both user definable), unless shutdown on safeties or outside air conditions.

4. Each boiler shall run subject to its own internal safeties and controls.
5. The boilers shall operate from the boiler management system controls furnished with the boilers. The boiler management system shall be set to operate the boilers in operating/standby mode.
   
a. The boiler management system shall modulate the boilers and boiler circulation pumps together to maximize energy efficiency.
   
b. On failure of any boiler, the functional boilers shall be staged to satisfy the heating load and The BAS shall indicate a boiler alarm condition.

6. The BAS shall monitor the heating water supply temperature. The heating water supply temperature setpoint shall vary linearly as a function of the outside air temperature via 4-20mA or 0-10VDC signal from the BAS Controller to the boiler management system. The hot water supply temperature setpoint shall vary in accordance with the following schedule, which shall be adjustable:

<table>
<thead>
<tr>
<th>Outside Air Temperature</th>
<th>Hot Water Supply Setpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td>0°F</td>
<td>180°F</td>
</tr>
<tr>
<td>20°F</td>
<td>160°F</td>
</tr>
<tr>
<td>55°F</td>
<td>120°F</td>
</tr>
</tbody>
</table>

COORDINATE THE FINAL RESET SCHEDULE WITH UNIVERSITY PROJECT MANAGER AND A/E.

7. A flow switch shall be furnished by the BAS Contractor and installed by the HVAC contractor in each boiler’s water outlet piping. BAS contractor shall provide control interlocks to the boiler controls in a manner approved by the boiler manufacturer to require proof of flow in order to enable the burner to fire.

B. New Boiler Circulation Pumps Control P-3, P-4:

1. The boiler pumps shall be interlocked to operate whenever the associated boiler is operating.

2. Pump status indication shall be via the flow switch installed in the piping near each pump.

3. Each boiler pump shall be controlled by the boiler control panel to maximize energy efficiency.

C. Heating Water Pump Control P-1, P-2 (ALTERNATE H-1):

1. The heating water pumps shall be operated in an operating/standby arrangement in conjunction with the boilers. The BAS shall determine which boiler is operating and shall operate the associated chilled water pump.

2. Provide start/stop, status and alarm for each pump.

3. On call for heating water, the operating pump shall run.

4. On pump failure the standby pump and associated chiller shall become the operating pump and chiller until the pump is repaired.

5. Pump operating status shall be provided through current sensing relays (University standard).
6. If alternate H-1 is accepted a new differential pressure sensor shall be installed in the piping system that will send a signal to a BAS to modulate the speed of the pumps via the variable frequency drive. The new sensor shall be located in mechanical room 175.

D. Existing High-Pressure Variable Volume Air Handling Units (AHU-1, AHU-2, AHU-3, AHU-4 & AHU-5)

1. Air Handling Units are existing to remain. The BAS Contractor shall replace the existing controller with a new DDC controller and implement the sequences specified herein.

   a. Automatic control dampers and control valves are existing with electric actuators. All damper and control valve actuators shall be reused. The BAS Contractor shall field verify the electrical characteristics of the valve and damper actuators and integrate them into the new BAS configuration.

   b. All sensors (temperature, pressure, CO2, airflow etc.) necessary to implement the sequence of operation below shall be new. Existing conduit pathways may be reused to the extent possible.

   c. Supply and return fan status shall be monitored by the BAS via new current sensing relays in addition to the status terminals on the existing VFDs.

   d. Individual air handling units shall be interlocked with certain exhaust fans as follows. The BAS Contractor shall provide exhaust fan start/stop control as needed to meet sequence of operation requirements. Existing start/stop wiring and conduit to motor control centers, starters, etc., may be reused to the extent possible. Exhaust fan status shall be provided by current sensing relays:

      1) EF-1 shall be enabled whenever AHU-1 and/or AHU-2 are enabled.
      2) EF-2 shall be enabled whenever AHU-3 is enabled.
      3) EF-3 shall be enabled whenever AHU-4 is enabled.
      4) EF-4 shall be enabled whenever AHU-5 is enabled.

2. The air handling unit shall have an occupied and unoccupied sequence of operation as described herein. The BAS Contractor shall be responsible for meeting with Miami University’s Facility Manager to determine the appropriate “occupied” days and hours of operation.

3. Unit to run continually during the “occupied” cycle as determined through BAS control. When the unit is indexed ON, the BAS system shall slowly ramp the supply and return fans up to speed (60 seconds minimum) and allow the dampers to modulate.

   a. Return air fans shall be arranged to “start” whenever the supply fans are operating.
4. When the unit is indexed to the “unoccupied” cycle, the outdoor and relief air dampers shall be closed, the return air damper opened, and the supply and return fans shut off and the adjustable frequency drives returned to the lowest setting. A temperature sensor downstream of the preheat coil shall modulate the preheat coil control valve to maintain a 55°F (adjustable) temperature inside the air handling unit. Unit shall remain in this position, except for unoccupied heating, cooling, and dehumidification and morning warm-up cycles, until the next occupied cycle.

5. The BAS shall modulate the return air damper opposite to the outside air and relief air dampers. The ventilation method minimum outside air percentage as shown on the drawings will require the relief damper to be opened at some percentage during the ventilation cycle.

6. New Carbon Dioxide (CO₂) sensors shall be provided by the BAS Contractor and located in the return air ductwork at the location of the existing CO₂ sensor being replaced. The DDC system shall monitor the CO₂ sensors for the worst case situation in the area supplied by the unit. The operator's terminal shall be alarmed when any of the sensors exceeds 1200 PPM or falls below 100 PPM for more than 30 minutes. The low setpoint indicates that the sensor has most likely failed.

7. The DDC system shall provide indication at the operator’s workstation when the air handling unit is in economizer operation. When the air handling unit is in normal economizer mode, the return air damper shall modulate opposite to the outside air dampers, and the relief air damper shall modulate with the OA damper with a 10% lag offset to control the discharge air temperature per the reset schedule and maintain the space at a slight positive pressure. The mixed air sensor shall prevent the mixed air temperature from dropping below 50°F (adjustable). Dampers shall modulate in sequence with the preheat and cooling coil valves to maintain the discharge air temperature.

   a. The air handling units do not currently have minimum outside air dampers or airflow measuring stations. These devices will not be provided as part of this project.

8. A new DDC static pressure sensor located approximately two-thirds down the length of the supply air duct run shall maintain the minimum duct static pressure by modulating the existing adjustable frequency drive on the supply fans. The BAS Contractor shall furnish and install the new sensor at the location of the current sensor (location shall be field verified by the BAS Contractor). The static pressure setpoint shall be reset based on zone damper position and airflow requirements as described below.

   a. The initial duct static pressure setpoint shall be 1.0” (adjustable).

   b. The AHU controller shall monitor the damper position of all associated VAV terminal units and determined each VAV AHU’s Critical Zone (CZ), which is the VAV terminal unit that has the lowest percentage of actual airflow compared to its current operating airflow setpoint.

   c. When the CZ damper is fully open and actual/setpoint airflow ratio is greater than 95%, (excess airflow/static) the duct static pressure setpoint shall be incrementally reset down by 10% of previous setpoint at a
frequency of 5 minutes to a minimum of 0.75" (adjustable) or the supply fan VFD has reached its lowest operating speed limit.

d. When the CZ damper is fully open and actual/setpoint airflow ratio is less than 90% (insufficient airflow/static) and space temperature is not satisfied, the reverse shall occur and the duct static pressure setpoint shall incrementally reset up to a maximum of 1.5" (adjustable). Monitor and alarm to DDC system if any zone cannot maintain at least 90% of actual/setpoint airflow ratio for more than 30 minutes (adjustable) if duct static pressure is at maximum setpoint.

The BAS shall modulate the speed of the return air fan to maintain a constant offset between the supply air volume and return air with the supply volume being greater. The offset shall be field verified in conjunction with the TABB Contractor and shall be adjustable.

A static pressure sensor in the mixed air plenum shall provide an alarm at the operator's terminal if the mixed air plenum pressure exceeds negative 0.75 inches (adjustable).

Install a manual reset low limit static pressure switch in the mixed air plenum to stop the fans, through the electrical control circuit, upon sensing a mixed air static pressure that exceeds negative 1.0 inches (adjustable). The DDC system shall monitor the mixed air pressure switch and provide an alarm at the operator's terminal when tripped.

Static pressure readout shall be provided at the operator's terminal for all duct static pressure sensors. The DDC system shall provide an alarm at the operator's workstation if the supply air duct static pressure falls 0.2 inches (adjustable) below setpoint.

Static pressure sensor location will be recorded on the control drawings and noted on the graphic display as part of this contract.

9. Install new a 2-pole manual reset high limit static pressure switch in the supply air discharge duct to stop the fans, through the electrical control circuit hard-wired to the VFD, upon sensing a discharge static pressure above 4.0 inches (adjustable). The DDC system shall monitor the high static pressure switch and provide an alarm at the operator's terminal when tripped.

10. The DDC system, with temperature sensors located in the outside air and supply air, shall modulate the existing outside, return and relief air dampers and the existing heating and cooling coil control valves in sequence to maintain the discharge air temperature setpoint. The discharge air temperature setpoint will be determined by an outside air temperature (OAT) reset schedule as follows:

<table>
<thead>
<tr>
<th>Outside Air Temp</th>
<th>Discharge Air Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°F</td>
<td>63°F</td>
</tr>
<tr>
<td>82°F</td>
<td>55°F</td>
</tr>
</tbody>
</table>

Reset schedule shall be easily adjustable from the operator's terminal.
a. Whenever the outside air is above 82°F or a VAV box space sensor senses a space temperature 4°F above setpoint, the supply air temperature reset shall be disabled, the supply air temperature shall be maintained at 55°F and an alarm shall be sent to the DDC control system.

b. The chilled water control valve shall also be closed whenever the chilled water system is not operational.

11. A temperature sensor in the mixed air plenum shall override the outside, return, and relief dampers to prevent the mixed air temperature from dropping below 50°F (adjustable).

12. The DDC system shall measure the outside air temperature and humidity and the return air temperature and humidity and the enthalpy of each determined. When the enthalpy of the outside air is less than the enthalpy of the return air the unit shall be allowed to operate in the economizer mode. When the enthalpy of the outside air exceeds the enthalpy of the return air, and mechanical cooling is available as determined by the DDC system, the economizer shall be disabled and the outside air damper returned to its minimum position.

13. A low limit DDC temperature sensor downstream of the preheat coil shall override the discharge air control and modulate the preheat coil control valve as required to maintain minimum 55°F (adjustable) air temperature downstream of the preheat coil. This same sensor shall modulate the preheat coil control valve to maintain minimum 55°F (adjustable) temperature inside the air handling unit when the unit is OFF.

14. The existing manual reset low limit thermostat(s) downstream of the preheat coil will stop the fans, through the electrical control circuit, upon sensing a discharge air temperature below 38°F (adjustable). The DDC system shall monitor the low limit thermostat. Upon a trip, the AHU fans will stop, outside and relief air dampers will fully close, and return dampers will open. The normally open hot water heating control valve will drive to the full open position.

15. Smoke detectors are existing to remain. Smoke control is currently as follows and will not be modified:

De-energize power to the supply and return fans through the fire alarm system.

16. The return air humidity sensor shall also monitor the return air humidity through DDC control to avoid a high humidity occurrence. When the return air relative humidity reaches 60% (adjustable), the unit shall go into an occupied dehumidification cycle. During the occupied dehumidification cycle, the supply and return fans shall operate at their current speed, the cooling control valve shall be modulated to maintain a 53°F supply air temperature, and the VAV box reheat coil control valves shall modulate to maintain the space temperature setpoint. When the space humidity reaches 55% (adjustable), the unit shall return to the normal occupied operation.

17. Unoccupied Setback Mode (OAT > 38°F)

a. During the unoccupied mode when the outside air temperature is above 40°F, the supply and return fans will be off. The outside and relief air dampers will be closed, return air damper open. Chilled water control
valve will be closed and the hot water pre heat coil valve will modulate to maintain 60°F as sensed by the mixed air temperature sensor.

b. The space temperature sensors will be sampled and if the temperature in the space drops below 62°F (adj), the supply and return fans will start, and the unit will ramp slowly to meet the static pressure control set point. Outside and relief air dampers and chilled water valve will all remain closed, return damper fully open. The hot water control valve will modulate to maintain 80°F. SAT set point (adj).

c. Once the space temperature rises above 65°F the supply and return fans will cycle off.

18. Unoccupied Setback Mode (OAT < 38°F)

a. During the unoccupied mode when the outside air temperature is less than 38°F., the supply fan(s) shall be off. The outside and relief air dampers shall be closed, return air damper open. Chilled water control valve shall be closed. The return fan shall operate at 50% speed to pressurize the mixed air chamber and provide limited air flow downstream. The hot water heating control valve shall modulate to maintain a supply temperature of 63°F.

b. The space temperature sensors shall be sampled and if the temperature in the space drops below 62°F (adj), the supply and return fans shall start, and the unit will ramp slowly to meet the static pressure control set point. Outside and relief air dampers and chilled water valve shall all remain closed, return damper fully open. The hot water control valve shall modulate to maintain 80°F. SAT set point (adj).

c. Once the space temperature rises above 65°F, the supply fan(s) shall cycle off.

19. Unoccupied Setup Mode

a. During the unoccupied mode the supply and return fans shall be off. The outside and relief air dampers shall be closed, return air damper open. Chilled water control valve shall be closed.

b. The space temperature sensors shall be sampled and if the temperature in the space rises above 82°F (adj), the supply and return fans shall start, and the unit shall ramp slowly to meet the static pressure control set point. Outside and relief air dampers and hot water valve shall all remain closed, return damper fully open. The chilled water control valve shall modulate to maintain 55°F. SAT set point.

c. Once the space temperature reaches 78°F. the supply and return fans shall cycle off.

d. The program shall be capable of morning warmup and cool down modes of operation as outlined below and operate only at the beginning of the occupied cycle. The function may be used as part of an optimization strategy with the normal occupied scheduling. Once the system enters the occupied mode, the warmup and/or cool down cycle shall not be allowed to operate again during the current occupied period.
20. Morning Warmup
   a. The supply and return fans shall start and ramp slowly to meet the static pressure control set point. The SAT set point shall be indexed to 90°F. (adj). The outside and relief air dampers shall be fully closed and the return air damper fully open. Chilled water control valve shall be closed. The VAV box control shall switch to the normal occupied control settings (see VAV seq of operation for detail).
   b. The unit shall remain in this mode until the average space temperature reaches 68°F. (return air temperature sensor may be used when appropriate). The program shall then switch to the normal occupancy mode.

21. Morning Cool Down
   a. The supply and return fans shall start and ramp slowly to meet the static pressure control set point. The program shall modulate the chilled water control valve to maintain a 55°F. SAT set point. The outside and relief air dampers shall be fully closed and the return air damper fully open, unless the outside air temperature and humidity is such that the economizer cycle can be utilized. Hot water control valve shall be closed. The VAV box control shall switch to the normal occupied control settings (see VAV seq of operation for detail).
   b. The unit shall remain in this mode until the average space temperature reaches 78°F. (return air temperature sensor may be used when appropriate). The program shall then switch to the normal occupancy mode.

22. Current sensing relays shall be provided for all supply and return fans to provide input for proof of fan operation in addition to speed drive contacts. The DDC system shall provide an alarm at the operator’s terminal upon detecting no airflow from any fan when the system is sequenced ON.

E. Existing Low-Pressure Constant Volume Air Handling Units (AHU-6, AHU-7 & AHU-9)

1. Air Handling Units are existing to remain. The BAS Contractor shall replace the existing controller with a new DDC controller and implement the sequences specified herein.
   a. Automatic control dampers and control valves are existing with electric actuators. All damper and control valve actuators shall be reused. The BAS Contractor shall field verify the electrical characteristics of the valve and damper actuators and integrate them into the new BAS configuration.
   b. All temperature and pressure sensors necessary to implement the sequence of operation below shall be new. Existing conduit pathways may be reused to the extent possible.
   c. Supply and return fan status shall be monitored by the BAS via new current sensing relays.
d. Individual air handling units shall be interlocked with certain exhaust fans as follows. The BAS Contractor shall provide exhaust fan start/stop control as needed to meet sequence of operation requirements. Existing start/stop wiring and conduit to motor control centers, starters, etc., may be reused to the extent possible. Exhaust fan status shall be provided by new current sensing relays:

1) EF-5 shall be enabled whenever AHU-7 is enabled.

3) EF-13 and EF-14 status shall be monitored by the BAS and AHU-9 shall be enabled when either exhaust fan is operating.

2. The air handling unit shall have an occupied and unoccupied sequence of operation as described herein. The BAS Contractor shall be responsible for meeting with Miami University’s Facility Manager to determine the appropriate “occupied” days and hours of operation.

3. Unit to run continually during the “occupied” cycle as determined through BAS control. When the unit is indexed ON, the BAS system shall start the supply and return fans and allow the dampers to modulate.

   a. Return air fans shall be arranged to “start” whenever the supply fans are operating.

4. When the unit is indexed to the “unoccupied” cycle, the outdoor and relief air dampers shall be closed, the return air damper opened, and the supply and return fans shut off. A temperature sensor downstream of the preheat coil shall modulate the preheat coil control valve to maintain a 55°F (adjustable) temperature inside the air handling unit. Unit shall remain in this position, except for unoccupied heating, cooling and morning warm-up cycles, until the next occupied cycle.

5. The BAS shall modulate the return air damper opposite to the outside air and relief air dampers.

6. The DDC system shall provide indication at the operator’s workstation when the air handling unit is in economizer operation. When the air handling unit is in normal economizer mode, the return air damper shall modulate opposite to the outside air dampers, and the relief air damper shall modulate with the OA damper with a 10% lag offset to control the discharge air temperature per the reset schedule and maintain the space at a slight positive pressure. The mixed air sensor shall prevent the mixed air temperature from dropping below 50°F (adjustable). Dampers shall modulate in sequence with the preheat and cooling coil valves to maintain the discharge air temperature.

   a. The air handling units do not currently have minimum outside air dampers or airflow measuring stations. These devices will not be provided as part of this project.

7. The DDC system, with new temperature sensors located in the outside air and occupied space (replace the existing space sensor in its current location), shall modulate the existing outside, return and relief air dampers and the existing heating and cooling coil control valves in sequence to maintain the space temperature setpoint.
The discharge air temperature setpoint during the cooling cycle will be determined by an outside air temperature (OAT) reset schedule as follows:

<table>
<thead>
<tr>
<th>Outside Air Temp</th>
<th>Discharge Air Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°F</td>
<td>63°F</td>
</tr>
<tr>
<td>82°F</td>
<td>55°F</td>
</tr>
</tbody>
</table>

Reset schedule shall be easily adjustable from the operator’s terminal.

Whenever the outside air is above 82°F, the supply air temperature reset shall be disabled, the supply air temperature shall be maintained at 55°F and an alarm shall be sent to the DDC control system.

9. The DDC system shall measure the outside air temperature and humidity and the return air temperature and humidity and the enthalpy of each determined. When the enthalpy of the outside air is less than the enthalpy of the return air the unit shall be allowed to operate in the economizer mode. When the enthalpy of the outside air exceeds the enthalpy of the return air, and mechanical cooling is available as determined by the DDC system, the economizer shall be disabled and the outside air damper returned to its minimum position.

10. Runaround Pump Control (P-1/AHU-7 & P-3/AHU-9 Only)

   1. For each air handling unit an outdoor air temperature sensor, through the BAS, shall start the pump serving the preheat coil on air handling unit when the outdoor air temperature drops below 45°F (adjustable). A current sensing relay from the pump starter shall be back to the DDC system to report pump status and alarm when a malfunction is detected.

   2. AHU-6 does not have a runaround pump.

11. A low limit DDC temperature sensor downstream of the preheat coil shall override the discharge air control and start the preheat coil runaround pump and modulate the preheat coil control valve as required to maintain minimum 55°F (adjustable) air temperature downstream of the preheat coil. This same sensor shall start the preheat coil runaround pump and modulate the preheat coil control valve to maintain minimum 55°F (adjustable) temperature inside the air handling unit when the unit is OFF.

12. The existing manual reset low limit thermostat(s) downstream of the preheat coil will stop the fans, through the electrical control circuit, upon sensing a discharge air temperature below 38°F (adjustable). The DDC system shall monitor the low limit thermostat. Upon a trip, the AHU fans will stop, outside and relief air dampers will fully close, and return dampers will open. The BAS shall start the runaround pumps and modulate the preheat coil control valve to maintain a 55°F temperature inside the unit when the low limit thermostat trips.

13. Smoke detectors are existing to remain. Smoke control is currently as follows and will not be modified: De-energize power to the supply and return fans through the fire alarm system.

14. Unoccupied Setback Mode (OAT > 38°F)
Miami University
Culinary Support Center Boiler & BAS Upgrades
Oxford, Ohio

15. Unoccupied Setback Mode (OAT < 38°F)

a. During the unoccupied mode when the outside air temperature is less than 38°F, the supply fan(s) shall be off. The outside and relief air dampers shall be closed, return air damper open. Chilled water control valve shall be closed. The return fan shall operate to pressurize the mixed air chamber and provide limited air flow downstream. The hot water heating control valve shall modulate to maintain a supply temperature of 63°F.

b. If the temperature in the space drops below 62°F (adj), the supply and return fans shall start. Outside and relief air dampers and chilled water valve shall all remain closed, return damper fully open. The hot water control valve shall modulate to maintain 80°F. SAT set point (adj).

c. Once the space temperature rises above 65°F, the return fan shall cycle off.

16. Unoccupied Setup Mode

a. During the unoccupied mode the supply and return fans shall be off. The outside and relief air dampers shall be closed, return air damper open. Chilled water control valve shall be closed.

b. If the temperature in the space rises above 82°F (adj), the supply and return fans shall start. Outside and relief air dampers and hot water valve shall all remain closed, return damper fully open. The chilled water control valve shall modulate to maintain 55°F. SAT set point.

c. Once the space temperature reaches 78°F, the supply and return fans shall cycle off.

d. The program shall be capable of morning warmup and cool down modes of operation as outlined below and operate only at the beginning of the occupied cycle. The function may be used as part of an optimization strategy with the normal occupied scheduling. Once the system enters the occupied mode, the warmup and/or cool down cycle shall not be allowed to operate again during the current occupied period.

17. Morning Warmup
a. The supply and return fans shall start. The SAT set point shall be indexed to 90°F (adj). The outside and relief air dampers shall be fully closed and the return air damper fully open. Chilled water control valve shall be closed.

b. The unit shall remain in this mode until the average space temperature reaches 68°F. The program shall then switch to the normal occupancy mode.

18. Morning Cool Down

a. The supply and return fans shall start. The program shall modulate the chilled water control valve to maintain a 55°F SAT set point. The outside and relief air dampers shall be fully closed and the return air damper fully open, unless the outside air temperature and humidity is such that the economizer cycle can be utilized. Hot water control valve shall be closed.

b. The unit shall remain in this mode until the average space temperature reaches 78°F. The program shall then switch to the normal occupancy mode.

19. Current sensing relays shall be provided for all supply and return fans to provide input for proof of fan operation. The DDC system shall provide an alarm at the operator's terminal upon detecting no air flow from any fan when the system is sequenced ON.

F. Existing 100% OA Variable Air Volume Air Handling Unit (AHU-8)

1. Air Handling Unit AHU-8 is existing to remain. The BAS Contractor shall replace the existing controller with a new DDC controller and implement the sequences specified herein.

a. Automatic and control valves and the outdoor air intake control damper are existing with electric actuators. All damper and control valve actuators shall be reused. The BAS Contractor shall field verify the electrical characteristics of the valve and damper actuators and integrate them into the new BAS configuration.

b. All temperature and pressure sensors necessary to implement the sequence of operation below shall be new. Existing conduit pathways may be reused to the extent possible.

c. Supply fan status shall be monitored by the BAS via new current sensing relays and status inputs on the existing VFD.

d. AHU-8 supply air volume shall be interlocked with certain exhaust fans as follows. The supply fan variable frequency drive will modulate to maintain air flow as required based upon the hood exhaust fan status. The required flow setpoint will be set via software to compensate for the hood fans. The existing air flow station shall be calibrated by the BAS Contractor and will monitor the supply air flow for control.

e. The BAS Contractor shall provide status and/or exhaust fan start/stop control and monitoring as needed to meet sequence of operation
requirements. Existing start/stop wiring and conduit to motor control centers, starters, etc., may be reused to the extent possible. Exhaust fan status shall be provided by new current sensing relays:

1) EF-6 (3,000 CFM) status monitored to index AHU-8 air flow.
2) EF-7 (3,000 CFM) status monitored to index AHU-8 air flow.
3) EF-8 (3,000 CFM) status monitored to index AHU-8 air flow.
4) EF-9 (3,000 CFM) status monitored to index AHU-8 air flow.
5) EF-10 (3,000 CFM) status monitored to index AHU-8 air flow.
6) EF-11 (3,000 CFM) is enabled whenever AHU-8 is energized. status is monitored.
7) The BAS Contractor shall determine the required fans speed increase associated with each fan in conjunction with the TABB Contractor.

2. The air handling unit shall have an occupied and unoccupied sequence of operation as described herein. The BAS Contractor shall be responsible for meeting with Miami University’s Facility Manager to determine the appropriate “occupied” days and hours of operation.

3. Unit to run continually during the “occupied” cycle as determined through BAS control. When the unit is indexed ON, the BAS system shall open the outdoor air damper and slowly ramp the supply and return fans up to speed (60 seconds minimum). And end switch shall be provided for the outside air damper to provide proof that the damper is open before the fan is permitted to start.

4. When the unit is indexed to the “unoccupied” cycle, the supply fan shut off and the outdoor air damper shall be closed. A temperature sensor downstream of the preheat coil shall modulate the preheat coil control valve to maintain a 55°F (adjustable) temperature inside the air handling unit.

5. The DDC system, with new temperature sensors located in the outside air and occupied space (replace the existing space sensor in its current location), shall modulate the existing heating and cooling coil control valves in sequence to maintain the space temperature setpoint (adjustable).

The discharge air temperature setpoint during the cooling cycle will be determined by an outside air temperature (OAT) reset schedule as follows:

<table>
<thead>
<tr>
<th>Outside Air Temp</th>
<th>Discharge Air Temp</th>
</tr>
</thead>
<tbody>
<tr>
<td>20°F</td>
<td>63°F</td>
</tr>
<tr>
<td>82°F</td>
<td>55°F</td>
</tr>
</tbody>
</table>

During cold weather conditions, while the fan is running, the heating control valve shall modulate to maintain a minimum of 50°F (Adj.) discharge air temperature. The reset schedule shall be easily adjustable from the operator’s terminal.
Whenever the outside air is above 82°F, the supply air temperature reset shall be disabled, the supply air temperature shall be maintained at 55°F and an alarm shall be sent to the DDC control system.

6. Runaround Pump Control (P-2/AHU-8)

1. An outdoor air temperature sensor, through the BAS, shall start the pump serving the preheat coil on air handling unit when the outdoor air temperature drops below 45°F (adjustable). A current sensing relay from the pump starter shall be back to the DDC system to report pump status and alarm when a malfunction is detected.

7. A low limit DDC temperature sensor downstream of the heating coil shall override the discharge air control and start the preheat coil runaround pump and modulate the preheat coil control valve as required to maintain minimum 55°F (adjustable) air temperature downstream of the preheat coil. This same sensor shall start the preheat coil runaround pump and modulate the preheat coil control valve to maintain minimum 55°F (adjustable) temperature inside the air handling unit when the unit is OFF.

8. The existing manual reset low limit thermostat(s) downstream of the preheat coil will stop the fans, through the electrical control circuit, upon sensing a discharge air temperature below 38°F (adjustable). The DDC system shall monitor the low limit thermostat. Upon a trip, the AHU fan will stop and the outside air damper will fully close open. The BAS shall start the runaround pumps and modulate the preheat coil control valve to maintain a 55°F temperature inside the unit when the low limit thermostat trips. The cooling coil control valve will be opened. An alarm shall be provided at the operator workstation.

9. Unoccupied Mode

a. The supply fan will be de-energized.

b. The outside air damper will be closed.

c. The DOC controller will energize the supply fan and EF-11 if space temperature foils below 65°F rises above 80°F. The heating and cooling valves will be operated as required, however the outdoor air damper will remain closed. Verify whether this sequence is required with the University before implementation.

10. Current sensing relays shall be provided for the supply and associated exhaust fans to provide input for proof of fan operation. The DDC system shall provide an alarm at the operator’s terminal upon detecting no air flow from any fan when the system is sequenced ON.

G. Existing Heating Only Low-Pressure Constant Volume Air Handling Unit (AHU-10)

1. Air Handling Unit is existing to remain. The BAS Contractor shall replace the existing controller with a new DDC controller and implement the sequences specified herein.

a. Automatic control dampers and the heating coil control valve are existing with electric actuators. All damper and control valve actuators shall be reused. The BAS Contractor shall field verify the electrical characteristics
of the valve and damper actuators and integrate them into the new BAS configuration.

b. All temperature and pressure sensors necessary to implement the sequence of operation below shall be new. Existing conduit pathways may be reused to the extent possible.

c. Supply and return fan status shall be monitored by the BAS via new current sensing relays.

2. The air handling unit shall have an occupied and unoccupied sequence of operation as described herein. The BAS Contractor shall be responsible for meeting with Miami University's Facility Manager to determine the appropriate "occupied" days and hours of operation.

3. Unit to run continually during the “occupied” cycle as determined through BAS control. When the unit is indexed ON, the BAS system shall start the supply and return fans and allow the dampers to modulate.

a. Return air fan shall be arranged to “start” whenever the supply fan is operating.

4. When the unit is indexed to the “unoccupied” cycle, the outdoor and relief air dampers shall be closed, the return air damper opened, and the supply and return fans shut off. A temperature sensor downstream of the heating coil shall modulate the heating coil control valve to maintain a 55°F (adjustable) temperature inside the air handling unit. Unit shall remain in this position, except for unoccupied heating and morning warm-up cycles, until the next occupied cycle.

5. The BAS shall modulate the return air damper opposite to the outside air and relief air dampers. AHU-10 shall be interlocked with certain exhaust fans as follows. Exhaust fan status shall be provided by new current sensing relays. Minimum outside air settings for AHU-10 will vary as follows:

a. With Cabinet washer exhaust (EF-Pan Wash) and dishwasher exhaust (EF-21) operating: 80% outside air minimum. BAS contractor shall field verify exhaust fan numbers.

b. Dishwasher exhaust operating (EF-21): 33% outside air minimum.

c. Cabinet washer and dishwasher exhausts inoperative: 0% outside air, 100% return air. The economizer dampers shall modulate if cooling is needed and free cooling is available via outside air.

6. The DDC system shall provide indication at the operator’s workstation when the air handling unit is in economizer operation. When the air handling unit is in normal economizer mode, the return air damper shall modulate opposite to the outside air dampers, and the relief air damper shall modulate with the OA damper with a 10% lag offset to control the discharge air temperature per the reset schedule and maintain the space at a slight positive pressure. The mixed air sensor shall prevent the mixed air temperature from dropping below 50°F (adjustable). Dampers shall modulate in sequence with the heating coil valve to maintain the discharge air temperature. The unit does not have cooling, however
“free-cooling” shall be used based on outside air enthalpy and space temperature requirements.

a. The unit does not have cooling, however “free-cooling” shall be used based on outside air enthalpy and space temperature requirements.

b. The air handling unit does not currently have a minimum outside air dampers or an airflow measuring station. These devices will not be provided as part of this project.

7. The DDC system, with new temperature sensors located in the outside air and occupied space (replace the existing space sensor in its current location), shall modulate the existing outside, return and relief air dampers and the existing heating coil control valve in sequence to maintain the space temperature setpoint.

The discharge air temperature setpoint during the cooling cycle will be determined by an outside air temperature (OAT) reset schedule as follows:

<table>
<thead>
<tr>
<th>Outside Air Temp</th>
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<td>82°F</td>
<td>55°F</td>
</tr>
</tbody>
</table>

Reset schedule shall be easily adjustable from the operator’s terminal.

8. The DDC system shall measure the outside air temperature and humidity and the return air temperature and humidity and the enthalpy of each determined. When the enthalpy of the outside air is less than the enthalpy of the return air the unit shall be allowed to operate in the economizer mode. When the enthalpy of the outside air exceeds the enthalpy of the return air, the economizer shall be disabled and the outside air damper returned to its minimum position.

9. Runaround Pump Control (P-4/AHU-10)

1. An outdoor air temperature sensor, through the BAS, shall start the pump serving the preheat coil on air handling unit when the outdoor air temperature drops below 45°F (adjustable). A current sensing relay from the pump starter shall be back to the DDC system to report pump status and alarm when a malfunction is detected.

10. A low limit DDC temperature sensor downstream of the preheat coil shall override the discharge air control and start the heating coil runaround pump and modulate the preheat coil control valve as required to maintain minimum 55°F (adjustable) air temperature downstream of the heating coil. This same sensor shall start the preheat coil runaround pump and modulate the heating coil control valve to maintain minimum 55°F (adjustable) temperature inside the air handling unit when the unit is OFF.

11. The existing manual reset low limit thermostat(s) downstream of the heating coil will stop the fans, through the electrical control circuit, upon sensing a discharge air temperature below 38°F (adjustable). The DDC system shall monitor the low limit thermostat. Upon a trip, the AHU fans will stop, outside and relief air dampers will fully close, and return dampers will open. The BAS shall start the...
runaround pump and modulate the heating coil control valve to maintain a 55°F temperature inside the unit when the low limit thermostat trips.

12. Smoke detectors are existing to remain. Smoke control is currently as follows and will not be modified: De-energize power to the supply and return fans through the fire alarm system.

13. Unoccupied Setback Mode (OAT > 38°F)
   a. During the unoccupied mode when the outside air temperature is above 40°F, the supply and return fans will be off. The outside and relief air dampers will be closed, return air damper open. The heating coil valve will modulate to maintain 60°F as sensed by the mixed air temperature sensor.
   b. If the temperature in the space drops below 62°F (adj), the supply and return fans will start. Outside and relief air dampers will all remain closed, return damper fully open. The heating coil control valve will modulate to maintain 80°F. SAT set point (adj).
   c. Once the space temperature rises above 65°F the supply and return fans will cycle off.

14. Unoccupied Setback Mode (OAT < 38°F)
   a. During the unoccupied mode when the outside air temperature is less than 38°F, the supply fan(s) shall be off. The outside and relief air dampers shall be closed, return air damper open. The return fan shall operate to pressurize the mixed air chamber and provide limited air flow downstream. The heating coil control valve shall modulate to maintain a supply temperature of 63°F.
   b. If the temperature in the space drops below 62°F (adj), the supply and return fans shall start. Outside and relief air dampers shall all remain closed, return damper fully open. The hot water control valve shall modulate to maintain 80°F. SAT set point (adj).
   c. Once the space temperature rises above 65°F, the return fan shall cycle off.

15. Morning Warmup
   a. The supply and return fans shall start. The SAT set point shall be indexed to 90°F. (adj). The outside and relief air dampers shall be fully closed and the return air damper fully open. Chilled water control valve shall be closed.
   b. The unit shall remain in this mode until the average space temperature reaches 68°F. The program shall then switch to the normal occupancy mode.

16. Current sensing relays shall be provided for the supply and return fans to provide input for proof of fan operation. The DDC system shall provide an alarm at the operator’s terminal upon detecting no air flow from any fan when the system is sequenced ON.
H. Variable Volume Box with Hot Water Reheat Control - New & Existing Boxes

1. This project includes a partial VAV box replacement as identified on the Drawings. Existing boxes not being replaced shall be retrofitted with new DDC Controllers, control valves, temperature sensors, discharge air sensors, and actuators.

2. The room temperature sensor and associated box mounted controller, discharge air sensor, and damper actuator shall be provided by the BAS Contractor. Box controllers and actuators shall be shipped to the box manufacturer for factory installation.

3. The VAV terminal box shall be provided with a direct digital microprocessor based controller. Electronic damper and reheat valves shall be provided capable of proportional control. A discharge air sensor shall be provided on the leaving side of the reheat coil on all VAV w/ reheat applications. Cooling only VAV applications will not require discharge air sensors.
   a. The occupied/unoccupied control of the VAV terminal will be dictated by the schedule of the air handling unit serving the terminal box.
   b. The campus set point standard is currently 70°F for heating and 74°F for cooling. Confirm setpoints with the University before implementing.

4. Occupied Mode
   a. During the occupied mode the VAV damper will modulate between minimum and maximum air flow settings to maintain the space temperature cooling set point. As the space temperature begins to decrease, the VAV will modulate towards the cooling minimum air flow setting (refer to the VAV box Schedule on Drawings for min settings).
   b. If the space temperature continues to decrease, reaching the heating set point, the damper will control to maintain the minimum air flow setting, and the reheat control valve will begin to open. Once the reheat valve position reaches 50%, the damper will begin to open and allow more air into the space.
   c. The damper will track along with the reheat valve until the reheat maximum cfm is reached. Reheat maximum air flow is 50% of the cooling maximum (adj). The valve will continue to open towards 100% as needed to maintain the space temperature heating set point.

5. Unoccupied Mode
   a. During the unoccupied mode, the air handling unit will be off. The VAV box unoccupied heating and cooling set points will be 62°F and 82°F respectively.
   b. Heating mode: If a temperature in the space drops below 62°F, the air handler will start and the VAV box will control to maintain the unoccupied heating set point. When the temperature in the space reaches 65°F, the air handler will stop.
c. Cooling mode: If a temperature in the space exceeds 82°F, the air handler will start and the VAV box will control to maintain the unoccupied cooling set point. When the temperature in the space reaches 78°F, the air handler will stop.

6. Unoccupied Standby Mode
   a. Standby mode requires the use of an occupancy sensor, mounted in the space, and connected to an input on the VAV controller.
   b. During normal occupancy when the air handler is in operation, but the space is empty, as sensed by the occupancy sensor, the VAV will enter a standby mode. During the standby mode, the minimum air flow setting will be 10% of the cooling max airflow, and the heating-cooling set points will be 68°F and 78°F respectively.
   C. The existing VAV-1-1 is currently interlocked with the ceiling occupancy sensor. After the VAV-1-1 is replaced the temperature controls contractor is required to rewire the occupancy sensor interlocked to work with the new box.

7. See VAV air handler sequence of operation for a detailed narrative of the setback and setup control.

8. All set points shall be fully adjustable.

I. Existing Chilled Water System
   1. Provide start/stop control and monitoring for all existing system components (chillers (2), pumps (2), remote air cooled condensers (2), chilled water supply and return temperatures, etc.). Refer to the attached points list and the previously provided original temperature control submittal for detailed requirements.

J. Existing Steam Boiler System
   1. Provide start/stop control and monitoring for the existing system to match that provided with the existing control system (start/stop, steam pressure and status). Refer to the attached points list and the previously provided original temperature control submittal for detailed requirements.

K. DDC Points Lists
   1. The following points shall be provided for each system as listed. Many of these points will be required to provide the specified operating sequence of the respective system. Others will be required for monitoring purposes only. Alarms shall be provided at the operator's terminal, coordinate alarm settings with Miami University’s Facility Manager. The existing heating water pumps are constant volume and will remain constant volume unless ALTERNATE H-1 is accepted. If alternate H-1 is accepted the heating water pump points noted below shall apply.

   a. Variable Flow Heating Water Pumps P-1 and P-2 (ALTERNATE H-1)
      1) Graphics
2) Pump P-1 start-stop status of pump through variable frequency drive auxiliary contact.
3) Pump P-2 start-stop status of pump through variable frequency drive auxiliary contact.
4) Heating water temperature sensors
5) Pump frequency output
6) Pumps differential pressure sensors

b. Existing Chilled Water System
   1) Graphics
   2) Chiller start-stop
   3) Status (Chillers & Air Cooled Condensers)
   4) Alarms
   5) Chilled water setpoint adjustment
   6) Chilled water supply and return temperatures

c. Boilers
   1) Graphics
   2) Boiler start-stop
   3) Boiler inlet water temperature
   4) Boiler outlet water temperature
   5) Status
   6) Alarm
   7) Provide setpoint adjustment and all available boiler temperature data to the BAS from the DDC interface furnished with the boilers.
   8) Provide status of the boiler circulation pumps furnished with the boilers.

d. Steam Boiler
   1) Graphics
   2) Boiler start-stop
   3) Steam Pressure
   4) Boiler status

e. Existing AHU-1
   1) Graphics
   2) Static pressure setpoint.
   3) Mixed air temperature
   4) Supply air temperature
   5) Monitor space pressure
   6) Exhaust damper position
   7) Economizer position
   8) Heating water valve position
   9) Chilled water valve position.
   10) Supply VFD speed
   11) Return fan VFD speed.
   12) Low limit static pressure.
   13) Supply fan status
   14) Return fan status.
   15) Smoke detector Status
   16) Supply fan start/stop
   17) Return fan start/stop

f. Existing AHU-2
1) Graphics
2) Static pressure setpoint
3) Mixed air temperature
4) Supply air temperature
5) Monitor space pressure
6) Exhaust damper position
7) Economizer position
8) Heating water valve position
9) Chilled water valve position
10) Supply fan VFD speed
11) Return fan VFD speed
12) Low limit static pressure.
13) Supply fan status
14) Return fan status
15) Smoke detector status.
16) Supply fan start/stop
17) Return fan start/stop

g. Existing AHU-3
1) Graphics
2) Mixed air temperature
3) Supply air temperature
4) Duct static pressure
5) Exhaust damper position
6) Economizer damper position
7) Heating water valve position
8) Chilled water valve position
9) Supply fan VFD speed.
10) Return fan VFD speed.
11) Low limit static pressure
12) Supply fan status
13) Return fan status
14) EF-1 Status
15) EF-2 Status
16) Smoke detector status.
17) Static pressure reset.
18) Return fan start/stop
19) Supply fan start/stop
20) EF-1 start/stop

h. Existing AHU-4
1) Graphics
2) Space temperature
3) Space temperature setpoint
4) Mixed air temperature
5) Supply air temperature
6) Duct static pressure setpoint
7) Exhaust damper position
8) Economizer damper position
9) Heating water valve position
10) Chilled water valve position
11) Supply fan VFD
12) Return fan VFD
13) Low limit static pressure
14) Supply fan status
15) Return fan status
16) Smoke detector status
17) Return fan start/stop
18) Supply fan start/stop

i. Existing AHU-5
1) Graphics
2) Duct static pressure setpoint
3) Mixed air temperature
4) Supply air temperature
5) Space temperature
6) Space pressure
7) Exhaust damper position
8) Economizer damper position
9) Heating water valve position
10) Chilled water valve position
11) Supply fan VFD speed
12) Return fan VFD speed
13) Static pressure low limit
14) Supply fan status
15) Return fan status
16) Smoke detector status
17) EF-3 Status
18) EF-4 Status
19) EF-5 Status
20) Restroom exhaust fan status.
21) Supply fan status
22) Return fan status
23) EF-3 start/stop
24) EF-4 start/stop
25) EF-5 start/stop
26) Restroom exhaust fan start/stop

j. EXISTING AHU-6
1) Graphics
2) Space temperature
3) Space temperature setpoint
4) Mixed air temperature
5) Supply air temperature
6) Exhaust damper position
7) Economizer damper position
8) Heating water valve position
9) Chilled water valve position
10) Return fan status
11) Low limit static pressure
12) Supply fan status
13) Return fan status
14) Smoke detector status
15) EF-6 status
16) EF-7 status
17) EF-9 status
18) EF-10 status
19) EF-11 status
20) EF-13 Status
21) Pan wash status
22) Supply fan start/stop
23) Return fan start/stop
24) EF-11 start/stop
25) EF-13 start/stop

k. EXISTING AHU-7
1) Graphics
2) Space temperature
3) Space temperature setpoint
4) Mixed air temperature
5) Supply air temperature
6) Exhaust damper position
7) Economizer damper position
8) Heating water valve position
9) Chilled water valve position
10) Low limit static pressure
11) Supply fan status
12) Return fan status
13) Smoke detector status
14) AHU-7 Runaround pump status
15) Return fan start/stop
16) Supply fan start/stop.
17) AHU-7 runaround pump start/stop

l. EXISTING AHU-8
1) Graphics
2) Space temperature
3) Space temperature setpoint
4) Air flow monitoring station
5) Space pressure
6) Discharge air temperature
7) Heating water valve position
8) Chilled water valve position
9) Supply fan VFD speed
10) Low Limit static pressure
11) Supply fan alarm
12) AHU-8 runaround pump status
13) Supply fan status
14) Supply fan start/stop
15) AHU-8 runaround pump start/stop

m. EXISTING AHU-9
1) Graphics
2) Space temperature
3) Space temperature setpoint
4) Mixed air temperature
5) Supply air temperature
6) Exhaust damper position
7) Economizer damper position
8) Heating water valve position
9) Chilled water valve position
10) Static pressure low limit
11) Supply fan status
12) Return fan status
13) Smoke detector status
14) AHU-9 runaround pump status
15) Supply fan start/stop
16) Return fan start/stop
17) AHU-9 runaround pump start/stop

n. EXISTING AHU-10
1) Graphics
2) Space temperature
3) Space temperature setpoint
4) Mixed air temperature
5) Supply air temperature
6) Above ceiling temperature
7) Exhaust damper position
8) Economizer damper position
9) Return fan VFD status
10) Supply fan VFD status
11) Chilled water valve position
12) Heating water valve position
13) Static pressure low limit
14) Supply fan static pressure
15) Return fan static pressure
16) Smoke detector status
17) EF-14 start/stop/status
18) Supply fan start/stop
19) AHU-10 runaround pump status
20) Return fan start/stop
21) Supply fan start/stop
22) AHU-10 runaround pump enable/disable.

o. Miscellaneous Equipment
1) Graphics
2) Chilled water supply temperature
3) Chilled water return temperature
4) Heating water supply temperature
5) Heating water return temperature
6) Outside air temperature
7) Outside air humidity
8) Steam boiler pressure
9) Steam boiler alarm
10) MCR temperature
11) Steam boiler status
12) Chilled water pump 1 status
13) Chilled water pump 2 status
14) Heating water pump 1 start/stop
15) Heating water pump 2 start/stop
16) Supply fan SF-1 start/stop
17) Steam boiler alarm
18) EF-21 status
19) Chilled water pump 1 start/stop
20) Chilled water pump 2 start/stop
21) SF-1 status
22) SF-1 damper position

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Miami University
Culinary Support Center Boiler & BAS Upgrades
Oxford, Ohio

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SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

A. Codes and Standards: All equipment, material and installations shall comply with applicable codes, Miami University Design Standards, and installation practices. Comply with the requirements of the applicable local building code, the applicable NEC, all local rules and regulations including those of the fire authorities. Comply with all applicable NFPA standards. All material and equipment shall be listed by the Underwriters Laboratories (UL) standard that is applicable for the specific purpose of the material and equipment. The National Electrical Code, National Electrical Manufacturer’s Association (NEMA) Standards, and applicable ANSI and IEEE standards shall apply to the pertinent materials, equipment, and installation practices. Testing shall be in accordance with the applicable International Electrical Testing Association (NETA) standards.

B. Permits and Fees: Obtain all permits and inspections required by all laws and regulations or public authority having such jurisdiction. File drawings necessary to obtain permits. Miami University will pay for all permits. Coordinate payment with the University's Project Manager.

C. Coordinate installation, equipment and manufacturers, within all Specifications Sections, with Miami University Design Standards manual.

1.02 INSPECTIONS

A. Obtain all inspections required by all laws, ordinances, rules, regulations or public authority having jurisdiction and obtain certificates of such inspections and submit same to the Engineer. Pay all fees, charges and other expenses in connection therein.

B. All work shall be inspected by the local authority having jurisdiction and upon completion of the work, the Electrical Contractor shall furnish to the State Architect, a certificate of inspection and approval from said Department before final payment on the Contract will be allowed. Fee for inspections shall be a part of this Contract.

1.03 ELECTRICAL SUBMITTALS

A. General: Submittals are not requested for all products covered in the specifications. Submit only the data requested under the submittals portion of each specification section. Un-requested submittals will not be processed or reviewed. FAX or photo copies are not allowed as submittals for operating and maintenance manuals. Submittals for operating and maintenance manuals must be on original manufacturer printed stock. Non-requirement of submittals, when so noted, is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications. Any deviation from specified items is considered a substitution. If the contractor desires to use other than specified items, then a formal request for substitution must be submitted prior to bid date, in accordance with the methods and times indicated in these specifications.
B. Before submitting a shop drawing or any related material to the Engineer, Contractor shall: review each such submission for conformance with the means, methods, techniques, sequences, and operations of construction, and safety precautions and programs incidental thereto, all of which are the sole responsibility of the Contractor; approve each such submission before submitting it; and so stamp each such submission before submitting it.

C. Definitions:
1. Product Data: Pre-printed manufacturer's data.
2. Shop Drawings: Drawings made specifically for the manufacture of a particular piece of equipment to be used on this project.

1.04 DRAWINGS AND SPECIFICATIONS

A. The mechanical and electrical drawings and specifications shall be considered as mutually explanatory and complementary. Any electrical work called for by one and not by the other shall be performed as though required by all. All sections and subsections of the Electrical work shall be governed by and subject to the general and supplementary conditions. Any discrepancies in or between the drawings and specifications, or between the drawings and actual field conditions shall be reported to the Engineer/Architect in sufficient time to issue an addendum for clarification.

B. The electrical drawings are diagrammatic, and some circuit runs have been distorted to avoid confusion of lines. However, the drawings indicate the general layout of the complete electrical system. Field verification of scale dimensions on plans is directed since actual locations, distance, and levels will be governed by actual field conditions.

1.05 WARRANTIES

A. Compile and assemble the warranties specified in Division 26, into a separated set of vinyl covered, three ring binders, tabulated and indexed for easy reference.

B. Provide complete warranty information for each item to include product or equipment to include date of beginning of warranty or bond; duration of warranty or bond; and names, addresses, and telephone numbers and procedures for filing a claim and obtaining warranty services.

C. This Contractor is responsible for all defects, repairs and replacements in materials and workmanship, for a period of one (1) year after final payment is approved by the Engineer.

D. Product guarantees greater than one (1) year shall be passed along to the Owner for full benefit of the manufacturer's warranty.

1.06 ELECTRICAL INSTALLATIONS

A. Coordinate electrical equipment and materials installation with other building components.

B. Verify all dimensions by field measurements.

C. Arrange for chases, slots, and openings in other building components to allow for electrical installations.

D. Coordinate the installation of required supporting devices and sleeves to be set in poured in place concrete and other structural components, as they are constructed.
E. Systems, materials, and equipment, which will be exposed in finished areas shall be installed level and plumb, parallel and perpendicular to other building systems and components.

F. Install electrical services and overhead equipment to provide the maximum headroom possible, where mounting heights are not detailed or dimensioned.

G. Install electrical equipment to facilitate maintenance and repair or replacement of equipment components. Maintain code clearances in front of and about all electrical equipment. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

H. Include in the work all labor, materials, equipment, services, apparatus, drawings (in addition to the Contract Documents) as required to complete the intended work.

I. Only new, clean and perfect equipment, apparatus, materials and supplies of latest design and manufacture shall be incorporated in the work in order to assure an electrical system of high quality.

PART 2 PRODUCTS

2.01 MISCELLANEOUS METALS

A. Steel plates, shapes, bars, and bar grating: ASTM A 36.

B. Cold-Formed Steel Tubing: ASTM A 500.

C. Hot-Rolled Steel Tubing: ASTM A 501.


E. Non-shrink, Nonmetallic Grout: Premixed, factory-packaged, non-staining, non-corrosive, nongaseous grout, recommended for interior and exterior applications.

F. Fasteners: Zinc-coated, type, grade, and class as required.

2.02 MISCELLANEOUS LUMBER

A. All lumber shall be fire treated.

B. Framing Materials: Standard Grade, light-framing-size lumber of any species. Number 3 Common or Standard Grade boards complying with WCLIB or AWPA rules, or Number 3 boards complying with SPIB rules. Lumber shall be preservative treated in accordance with WPB LP-2, and kiln dried to a moisture content of not more than 19 percent.

C. Construction Panels: Plywood panels; APA C-D PLUGGED INT, with exterior glue; thickness as indicated but not less than 15/32 inches.

2.03 Fire-stopping materials:

A. Products: Subject to compliance with project and Underwriters Laboratories requirements, provide materials by one of the following:
   a. 3M, unless otherwise required by the UL System to be used.
PART 3 EXECUTION

3.01 EXAMINATION
A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting installation and application of sealants and access panels. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 ERECTION OF METAL SUPPORTS AND ANCHORAGE
A. Cut, fit, and place miscellaneous metal fabrications accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
B. Field Welding: Comply with AWS “Structural Welding Code.”

3.03 ERECTION OF WOOD SUPPORTS AND ANCHORAGE
A. Cut, fit, and place wood grounds, nailers, blocking, and anchorage accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
B. Select fastener sizes that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood members.
C. Attach to substrates as required to support applied loads.

3.04 APPLICATION OF SEALERS
A. General: Comply with sealer manufacturers' printed application instructions applicable to products and applications indicated, except where more stringent requirements apply.

B. Tooling: Immediately after sealant application and prior to time shining or curing begins, tool sealants to form smooth, uniform beads; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealants from surfaces adjacent to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by sealant manufacturer.

C. Apply rated firestopping sealants at all penetrations of fire and smoke walls; at all penetrations of floors and at other locations as noted on the drawings or where required by code. Consider walls that are common to different abutting buildings, to different additions to buildings, and to fire and smoke separations within buildings as requiring fire stopping sealant. Refer to architectural drawings. When in doubt, consult with Engineer or Architect.
   1. Submit the following approval before ordering materials for fire stopping:
      a. Fire stopping detail, including Underwriters Laboratories System Number, as listed in Volume 2 of the UL Fire Resistance Directory, for each different intended project application, such as cable tray penetration, conduit penetration, penetration of one-hour gypsum penetration, penetration of two hour concrete slab, etc.
      b. Fire stopping material manufacturer. This manufacturer must be listed in the applicable UL System Number detail.
c. Submittals for approval by the engineer are not required for other items in this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

END OF SECTION 260500
SECTION 26 05 19
LOW-VOLTAGE CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY
A. This Section includes wires, cables, electrical tape and connectors for power, lighting, signal, control and related systems rated 600 volts and less.

1.02 SUBMITTALS
A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

1.03 QUALITY ASSURANCE
A. Regulatory Requirements: Comply with provisions of the following code:
   1. NFPA 70 "National Electrical Code;"
      a. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.
   2. UL Compliance: Provide components which are listed and labeled by Underwriters Laboratories under the following standards.
      a. UL Std. 83 Thermoplastic-Insulated Wires and Cables
      b. UL Std. 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors
   3. NEMA and ICEA Compliance: Provide components which comply with the following standards:
      a. WC-5: Thermoplastic-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy
      b. WC-7: Cross Linked Thermosetting
      c. Polyethylene-Insulated Wire and Cable for the Transmission and Distribution of Electrical Energy

PART 2 PRODUCTS

2.01 MANUFACTURERS
A. Insulated tap connector:
   1. Blackburn Series IPC
   2. Buchanon B-Tap

B. Spring Wire Connectors for AWG sizes Number 14 to Number 10 in dry locations:
   1. 3M Scotchlok Y, R, G, and B
   2. Ideal Wingnut
   3. Thomas & Betts Type PT

C. Threaded on Wire Connectors for AWG sizes Number 8 and larger:
   1. Raychem TCS (indoor)
2. Raychem WCSM (exterior)

D. Spring Wire Connectors for AWG sizes Number 14 to Number 10 in wet and damp locations:
   1. King Technology "One-Step" Model King-4, 5, 6, 9 Silicone-Filled Safety Connectors

E. Below Grade Wiring Connectors:
   1. 3M In-Line Cold Shrink Splice.
   2. King Technology "One-Step" Model King-4, 5, 6, 9 Silicone-Filled Safety Connectors.

2.02 WIRES AND CABLES

A. General: Provide wire and cable suitable for the temperature, conditions and location where installed.

B. Single Conductors for General Power and Lighting Circuits:
   1. Stranding: Provide stranded conductors for lighting circuits and non-vibrating power utilization equipment utilizing Number 10 AWG and smaller and stranded conductors for Number 8 AWG and larger. Provide stranded conductors, regardless of size, for connections to vibrating equipment such as motors and transformers.
   2. Conductors of AWG Number 10 and smaller for lighting circuits and non-vibrating power utilization equipment may be stranded if used with devices, lugs and connectors specifically applicable for stranded conductors. Stranded conductors are not to be used with screw head binding, such as with side wired devices. Proper back-wired or pressure devices UL listed for stranded conductor termination must be used where stranded conductors are selected.
   3. Use stranded conductors for control circuits.
   4. Conductor Material: Copper for all wires and cables.
   5. Insulation: Provide XHHW or THHN or THWN insulation for all conductors. Provide XHHW or THWN for all conductors installed outdoors or underground
   6. Color Coding for phase identification in accordance with Part 3 below.

PART 3 EXECUTION

3.01 WIRING METHOD

A. Install all wire in raceway.

3.02 PREPARATION

A. Completely and thoroughly swab raceway before installing wire.

3.03 INSTALLATION OF WIRES AND CABLES

A. Install electrical cables, wires, and connectors in compliance with NEC.

B. Pull conductors simultaneously where more than one is being installed in same raceway. Use UL listed pulling compound or lubricant where necessary.

LOW VOLTAGE CONDUCTORS AND CABLES
C. Use pulling means including, fish tape, cable, rope, and basket weave wire and cable grips which will not damage cables or raceways. Do not use rope hitches for pulling attachment to wire or cable. Do not exceed maximum tensile strength of conductor or grip. Do not exceed maximum sidewall pressure limitations of cables.

D. Keep conductor splices to minimum.

E. Install splice and tap connectors which possess equivalent or better mechanical strength and insulation rating than conductors being spliced.

F. Use splice and tap connectors which are compatible with conductor material.

G. Provide adequate length of conductors within electrical enclosures and train the conductors to terminal points with no excess. Bundle multiple conductors, with conductors larger than Number 10 AWG cabled in individual circuits. Make terminations so there is no more than 1/8 inch of exposed bare conductor at the terminal.

H. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in UL 486A and UL 486B.

I. Use conductor not smaller than Number 12 AWG for power and lighting circuits.

J. Single conductors used for control circuits shall not be smaller than Number 14 AWG.

K. Feeder conductors shall be continuous and shall not contain splices.


M. Clean conductor surfaces before installing lugs and connectors.

N. Make splices, taps, and terminations to carry full ampacity of conductors.
   1. Install splices and taps which possess equivalent-or-better mechanical strength and insulation ratings than conductors being spliced.
   2. Use splice and tap connectors which are compatible with conductor material.

O. Above grade:
   1. Use pre-molded insulated tap connectors for copper conductor splices and taps, Number 8 AWG and larger. Insulate with UL listed insulating cover supplied by same manufacturer as connector.
   2. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, Number 10 AWG and smaller.
   3. Tape uninsulated conductors and connectors with electrical tape to 150 percent of insulation rating of conductor, or three layers of tape, whichever is greater.

P. Below grade:
   1. Use specified insulated connectors suitable and approved for below grade wiring connectors. Ensure that conductors do not apply tension to splice.
3.04 FIELD QUALITY CONTROL

A. Inspect wire for physical damage and proper connection.

B. Measure tightness of bolted connections with properly scaled and calibrated torque tool and compare torque measurements with manufacturer’s recommended values.

C. Before energizing, verify continuity and isolation of each branch circuit conductor.

D. Conductor Color Coding:
   1. Color code secondary service, feeder, and branch circuit conductors, as follows:
      | 208Y/120 Volts | Phase | 480Y/277 Volts |
      | Black         | A     | Brown          |
      | Red           | B     | Orange         |
      | Blue          | C     | Yellow         |
      | White         | Neutral | Gray        |
      | Green         | Ground | Green        |

   2. Permanently post this identification table at all branch circuit panelboards.

E. Conductor Color Coding Methods: Use conductors with color factory-applied the entire length of the conductors except that the following field-applied color-coding methods may be used in lieu of factory-coded wire for sizes larger than Number 6 AWG.

F. For phase conductors:
   1. Apply colored, pressure-sensitive plastic tape in half-lapped turns for a distance of 4 inches from terminal points and in boxes where splices or taps are made. Apply the last two laps of tape with no tension to prevent possible unwinding. Use 1/2 or 3/4 inch-wide 3M Scotch #35 tape in colors as specified. Do not obliterate cable identification markings by taping. Tape locations may be adjusted slightly to prevent such obliteration.
   2. In lieu of pressure-sensitive tape, colored non-conductive cable ties may be used for color identification. Apply three ties of specified color to each wire at each terminal or splice point starting 3 inches from the terminal and spaced 3 inches apart. Apply with a special tool or pliers, tighten for snug fit, and cut off excess length.

G. For neutral conductor:
   1. Same as for phase conductors except that three continuous white strips, factory applied, shall be used. Cable ties not allowed.

H. For ground conductor:
   1. Same as for phase conductors except that cable ties are not allowed.

I. Prior to energizing, test wires and cables for electrical continuity and for short circuits.

J. Subsequent to wire and cable hook-ups, energize circuits and demonstrate proper functioning. Correct malfunctioning units, and retest to demonstrate compliance.

END OF SECTION 26 05 19
SECTION 26 05 26

GROUNDING AND BONDING

PART 1  GENERAL

1.01 SUMMARY

A. This Section includes solid grounding of electrical systems and equipment. It includes basic requirements for grounding for protection of life, equipment, circuits, and systems. Grounding requirements specified in this Section may be supplemented in other sections of these Specifications.

1.02 SUBMITTALS

A. Submittals for approval by the Engineer of products to be used are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

1.03 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this Section that are listed and labeled for the specific purposes by Underwriter's Laboratories.

B. Electrical Component Standard: Components and installation shall comply with NFPA 70, "National Electrical Code" (NEC).

C. UL Standard: Comply with UL 467, "Grounding and Bonding Equipment."

PART 2  PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. A.B. Chance Co.
2. Blackburn Co.
3. Erico Products, Inc.
4. Ideal Industries, Inc.
7. O-Z/Gedney Co.
8. Raco, Inc.
9. Thomas & Betts Corp.

2.02 GROUNDING AND BONDING PRODUCTS

A. Products: Of types indicated and of sizes and ratings to comply with NEC. Where types, sizes, ratings, and quantities indicated are in excess of NEC requirements, the more stringent requirements and the greater size, rating, and quantity indications govern.

B. Conductor Materials: Copper.
2.03 WIRE AND CABLE CONDUCTORS

A. General: Comply with Division 26 Section "Low-Voltage Electrical Power and Cables." Conform to NEC Table 8, except as otherwise indicated, for conductor properties, including stranding.

B. Equipment Grounding Conductor: Copper, green insulated.

C. Grounding Electrode Conductor: Copper, stranded cable.

D. Bare Copper Conductors: Conform to the following:

PART 3 EXECUTION

3.01 APPLICATION

A. Equipment Grounding Conductor Application: Comply with NEC Article 250 for sizes and quantities of equipment grounding conductors, except where larger sizes or more conductors are indicated.

B. Install separate insulated equipment grounding conductors with circuit conductors for all feeders and branch circuits.

C. Nonmetallic Raceways: Install an insulated equipment ground conductor in nonmetallic raceways containing power conductors.

D. Underground Conductors: Bare, stranded copper except as otherwise indicated.

3.02 CONNECTIONS

A. Make connections with clean bare metal at points of contact.

B. Coat and seal connections involving dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.

C. Terminate insulated equipment grounding conductors for feeders and branch circuits with pressure-type grounding lugs. Where metallic raceways terminate at metallic housings, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to the ground bus or lug in the housing. Bond conduits at both entrances and exits with grounding bushings and bare grounding conductors.

D. Tighten grounding and bonding connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values for connectors and bolts. Where manufacturer's torqueing requirements are not indicated, tighten connections to comply with torque tightening values specified in UL 486A and UL 486B.
E. Compression-Type Connections: Use hydraulic compression tools to provide the correct circumferential pressure for compression connectors. Use tools and dies recommended by the manufacturer of the connectors. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on the ground conductor.

END OF SECTION 26 05 26
PART 1 GENERAL

1.01 SUMMARY

A. This Section includes secure support from the building structure for electrical items by means of hangers, supports, anchors, sleeves, inserts, seals, and associated fastenings.

B. Refer to other Division 26 sections for additional specific support requirements that may be applicable to specific items.

1.02 SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

1.03 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

B. Electrical components shall be listed and labeled for the specific intended purpose by Underwriters Laboratories, Inc.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:

1. Slotted Metal Angle and U-Channel Systems:
   a. Allied Tube & Conduit
   b. American Electric
   c. B-Line Systems, Inc.
   d. Cinch Clamp Co., Inc.
   e. GS Metals Corp.
   f. Haydon Corp.
   g. Kin-Line, Inc.
   h. Unistrut Diversified Products

2. Conduit Sealing Bushings:
   a. Bridgeport Fittings, Inc.
   c. O-Z/Gedney
   d. Raco, Inc.
   e. Red Seal Electric Corp.
   f. Spring City Electrical Mfg. Co.
   g. Thomas & Betts Corp.
2.02 COATINGS

A. Coating: Supports, support hardware, and fasteners shall be protected with zinc coating or with treatment of equivalent corrosion resistance using approved alternative treatment, finish, or inherent material characteristic.

2.03 MANUFACTURED SUPPORTING DEVICES

A. Raceway Supports: Clevis hangers, riser clamps, conduit straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring steel clamps.

B. Fasteners: Types, materials, and construction features as follows:
   1. Expansion Anchors: Carbon steel wedge or sleeve type.
   2. Toggle Bolts: All steel springhead type.

C. Conduit Sealing Bushings: Factory-fabricated watertight conduit sealing bushing assemblies suitable for sealing around conduit, or tubing passing through concrete floors and walls. Construct seals with steel sleeve, malleable iron body, neoprene sealing grommets or rings, metal pressure rings, pressure clamps, and cap screws.

D. U-Channel Systems: 16-gauge steel channels, with 9/16-inch-diameter holes, between one and one half and two and one half inches on center, in top surface. Provide fittings and accessories that mate and match with U-channel and are of the same manufacture.

2.04 FABRICATED SUPPORTING DEVICES

A. General: Shop- or field-fabricated supports or manufactured supports assembled from U-channel components.

B. Steel Brackets: Fabricated of angles, channels, and other standard structural shapes. Connect with welds and machine bolts to form rigid supports.

C. Pipe Sleeves: Provide pipe sleeves of one of the following:
   1. Interior Dry Locations: Fabricate from Schedule 40 galvanized steel pipe or Schedule 40 PVC plastic pipe.
   2. Exterior or Interior Wet or Damp Locations: Fabricate from Schedule 40 PVC plastic pipe.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install supporting devices to fasten electrical components securely and permanently in accordance with NEC requirements.

B. Coordinate with the building structural system and with other electrical installation.

C. Raceway Supports: Comply with the NEC.

D. Conform to manufacturer's recommendations for selection and installation of supports.

E. Strength of each support shall be adequate to carry present and future load multiplied by a safety factor of at least four. Where this determination results in a safety allowance of
less than 200 lbs, provide additional strength until there is a minimum of 200 lbs safety allowance in the strength of each support.

F. Install individual and multiple (trapeze) raceway hangers and riser clamps as necessary to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assembly and for securing hanger rods and conduits.

G. Support parallel runs of horizontal raceways together on trapeze-type hangers.

H. Support individual horizontal raceways by separate pipe hangers. Spring steel fasteners may be used in lieu of hangers only for 1 inch and smaller raceways serving branch circuits, telephone and data above suspended ceilings only. For hanger rods with spring steel fasteners, use 1/4-inch-diameter or larger threaded steel. Use spring steel fasteners that are specifically designed for supporting single conduits or tubing.

I. Space supports for raceway in accordance with NEC.

J. Support exposed and concealed raceway within 3 feet of boxes, access fittings, device boxes, cabinets or other raceway terminations.

K. In vertical runs, arrange support so the load produced by the weight of the raceway and the enclosed conductors is carried entirely by the conduit supports with no weight load on raceway terminals.

L. Miscellaneous Supports: Support miscellaneous electrical components as required to produce the same structural safety factors as specified for raceway supports. Install metal channel racks for mounting cabinets, panelboards, disconnects, control enclosures, pull boxes, junction boxes, transformers, and other devices.

M. Sleeves: Install in concrete slabs and walls and all other fire-rated floors and walls for raceways and cable installations. Provide insulated bushings at each end of sleeve. For sleeves through fire rated-wall or floor construction, apply UL-listed firestopping sealant in gaps between sleeves and enclosed conduits and cables.

N. Conduit Seals: Install seals for conduit penetrations of slabs on grade and exterior walls below grade and where indicated. Tighten sleeve seal screws until sealing grommets have expanded to form watertight seal.

O. Fastening: Unless otherwise indicated, fasten electrical items and their supporting hardware securely to the building structure, including but not limited to conduits, raceways, cables, cable trays, busways, cabinets, panelboards, transformers, boxes, motor control centers, disconnect switches, and control components in accordance with the following:

1. Fasten by means of wood screws or screw-type nails on wood, toggle bolts on hollow masonry units, concrete inserts or expansion bolts on concrete or solid masonry, and machine screws, welded threaded studs, or spring-tension clamps on steel. Do not weld conduit, pipe straps, or items other than threaded studs to steel structures. In partitions of light steel construction, use sheet metal screws.

2. Holes cut to depth of more than 1-1/2 inches in reinforced concrete beams or to depth of more than 3/4 inch in concrete shall not cut the main reinforcing bars. Fill holes that are not used.

3. Ensure that the load applied to any fastener does not exceed 25 percent of the proof test load. Use vibration- and shock-resistant fasteners for attachments to concrete slabs.
END OF SECTION 26 05 29
SECTION 26 05 33
RACEWAYS AND BOXES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Raceways include the following:
   1. Rigid metal conduit
   2. Intermediate metal conduit
   3. Rigid non-metallic conduit and duct
   4. Electrical metallic tubing (EMT)
   5. Flexible metal conduit
   6. Liquidtight flexible conduit
   7. Boxes, enclosures, and cabinets

1.02 SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

1.03 QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" for components and installation.

B. Listing and Labeling: Provide products specified in this Section that are listed and labeled by Underwriter's Laboratories for the specific purpose and comply with the following standards:
   1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
   2. ANSI C80.3 - Electrical Metallic Tubing, Zinc Coated.
   3. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
   5. NECA 1 "Standard practice of Good Workmanship in Electrical Construction (ANSI)."
   6. NEMA TC 2 - Electrical Plastic Conduit (EPC-40 and EPC-80).
   7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

C. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 PRODUCTS

2.01 CONDUIT REQUIREMENTS

A. General: Provide conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated. Where types and grades are not indicated,
provide proper selection determined by Installer to fulfill wiring requirements, and comply with applicable portions of NEC for raceways.

B. Minimum Size: 3/4 inch, switch legs may be ½ inch minimum, and fixture heat whips may be 1/2 inch minimum.

2.02 METAL CONDUIT

A. Rigid Steel Conduit: Conduit to be seamless, hot dipped galvanized rigid steel. Threads to be cut and ends chamfered prior to galvanizing. Galvanizing to provide zinc coating fused to inside and outside walls of conduit. Provide an enamel lubricating coating on the inside of the conduit. Conduit to conform to ANSI C80.1 and listed and labeled under UL 6.

B. Intermediate Metal Conduit: Conduit to be seamless, hot dipped galvanized rigid steel. Threads to be cut and ends chamfered prior to galvanizing. Galvanizing to provide zinc coating fused to outside walls of conduit. Provide an enamel lubricating coating on the inside of the conduit. Conduit to be listed and labeled under UL 1242.

C. Fittings and Conduit Bodies: ANSI/NEMA FB 1; material to match conduit. Couplings for rigid steel conduit and IMC to be single piece threaded, cadmium plated malleable iron. Conduit bodies may be aluminum. Hubs for box connection to be two-piece with outer internally threaded hub to receive conduit and inner locking ring with bonding screw. Expansion fittings shall allow for a minimum of four inches of movement and shall be similar to O-Z Gedney AX series, complete with bonding jumpers and hardware.

D. Raintight Sealing Hubs: Two piece type with outer internally-threaded hub to receive conduit, inner locking ring with bonding screw, insulated throat, and V-shaped ring or O-ring .

1. Manufacturers: Thomas & Betts H series or Bridgeport.

2.03 FLEXIBLE METAL CONDUIT AND FITTINGS

A. Description: Interlocked steel construction.

B. Flexible Metal Steel Conduit: Conduit to be constructed of spirally wrapped, convoluted hot dip galvanized steel strip. Zinc coating to cover both sides and all edges of steel strip. Convolutions to be interlocked to prevent separation when conduit is bent at radius equal to 4-1/2 times conduit O.D. Conduit to be listed and labeled under UL 1 - 1985.

2.04 LIQUIDtight FLEXIBLE METAL CONDUIT and FITTINGS

A. Liquidtight flexible metal conduit and fittings shall meet the same construction specifications as flexible metal conduit above and shall have an outer PVC jacket.

B. Liquidtight Flexible Metal Steel Conduit: Conduit to be listed and labeled under UL 360 - 1986.

C. Liquidtight flexible conduit connectors to consist of body, cone (ferrule), sealing gland, and nut. Fitting to be UL 514B - 1987 listed for grounding. Body to be cadmium plated malleable iron and have male and female thread for attachment to box or conduit as required.
2.05 **ELECTRICAL METALLIC TUBING (EMT) and FITTINGS**

A. **Description:** Conduit to be seamless, hot dipped or electro-galvanized steel tubing. Galvanizing to provide zinc coating fused to outside walls of conduit. Provide an enamel lubricating coating on the inside of the conduit. Conduit to conform to ANSI C80.3 - 1983 and listed and labeled under UL 797 - 1983.

B. **Provide steel set-screw type connectors and couplings for interior EMT fittings.** Connectors and fittings to be cadmium plated, zinc plated steel, or malleable iron fittings and include insulated throats. Die cast fittings, components, and indenter type couplings and connectors are not allowed.

C. **Expansion fittings for use with EMT shall allow for a minimum of four inches of movement and shall be similar to O-Z Gedney TX series, complete with bonding jumpers and hardware.**

2.06 **CONDUIT BUSHINGS**

A. Bushings for terminating conduits smaller than 1-1/4 inches are to have flared bottom and ribbed sides, with smooth upper edges to prevent injury to cable insulation. Install insulated type bushings for terminating conduits 1-1/4 inches and larger. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing. Bushings to have screw type grounding terminal.

2.07 **RIGID NONMETALLIC CONDUIT AND DUCT**

A. **Description:**

1. **Rigid Non-Metallic Conduit:** Conduit to be PVC, Schedule 40 or Schedule 80 as indicated, conforming to ANSI, NEMA specifications and be listed and labeled under UL 651. May be used in or under concrete slabs on grade and in exterior when concrete encased {3 in. minimum cover},

B. **Fittings and Conduit Bodies:**

1. **Rigid non-metallic conduit connectors and couplings to be manufactured per NEMA TC-3 and UL 651 listed.**

2.08 **NONMETALLIC CONDUIT FITTINGS**

A. **PVC Conduit and Tubing Fittings:** NEMA TC 3; match to conduit, tubing type and material. Expansion fittings shall allow for six inch movement, and shall be similar to Carlon E945 series.

2.09 **PULL AND JUNCTION BOXES**

A. **Small Sheet Metal Boxes:** NEMA OS 1. Flush-mounted boxes shall have an overlapping cover.

B. **Cast Metal Boxes:** NEMA FB 1, cast aluminum with gasketed cover.

C. **Surface-mounted boxes:** Screw-on or hinged cover.

D. **Covers shall be the same material as the box.** Cover shall be on the largest access side of the box, unless otherwise indicated.

E. **Boxes located outdoors above ground shall be raintight and gasketed cast aluminum.**
F. Boxes located in the ground or in wet or damp locations shall be cast malleable iron having cadmium finish, unless otherwise indicated.

2.10 CONDUIT BODIES

A. Cast metal of type, shape and size to fit location and conduit.

B. Constructed with threaded conduit ends, removable cover, corrosion-resistant screws.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive raceways, boxes, enclosures, and cabinets for compliance with installation tolerances and other conditions affecting performance of the raceway system. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 WIRING METHODS FOR 600 VOLTS AND LESS

A. Outdoor and Interior Wet and Damp Locations:
   1. Underground Installations or under slab on grade: Use Schedule 40 PVC conduit a minimum of 3" below slab. Use rigid steel conduit for stub ups from slab and from below grade
   2. Above Grade and Interior Wet and Damp Locations: Use rigid steel conduit. Provide spacers to maintain a minimum of 1/4 inch gap between the conduit and masonry and other surfaces detrimental to aluminum conduit.
   3. Connections to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Flexible Liquidtight flexible metal conduit.
   4. Boxes and Enclosures: NEMA Type 3R or Type 4, unless noted otherwise on the drawings.

B. Dry Interior Locations:
   1. Concealed in Walls and Ceilings: Use electrical metallic tubing unless noted otherwise on drawings.
   2. Exposed: Unless otherwise indicated on the drawings, the following shall apply:
      a. Use rigid metal or intermediate metal conduit within 6 feet 0 inches of the floor in areas subject to physical damage such as mechanical areas, loading dock areas, generator rooms and storerooms. Electrical metallic tubing may be used above 6 feet 0 inches from the floor and where not subject to physical damage. Rooms dedicated solely to electrical equipment do not require rigid metal or intermediate metal conduit, unless required elsewhere in the documents or by code, such as for medium voltage circuits.
   3. Connections to Vibrating Equipment (including transformers and hydraulic, pneumatic, or electric solenoid or motor-driven equipment): Liquid-tight flexible metal conduit. Use Liquidtight flexible metal conduit where subject to oil drips or spray and all other areas which are not completely free of spray, vapor and liquids.
   4. Boxes and Enclosures: NEMA Type 1, unless noted otherwise on the drawings.

3.03 INSTALLATION

A. Do not reduce the indicated sizes of raceways.

RACEWAYS AND BOXES
B. Do not install any raceway in concrete slabs. Under slab conduits to be a minimum of 3" below slab.

C. Raceway routing shown on Drawings in approximate locations unless dimensioned. Route as required to complete wiring system. Verify field measurements and routing and termination locations of raceway prior to rough-in. Raceways are not to cross pipe shafts, or ventilating duct openings, nor are they to pass through HVAC ducts. Support riser raceway at each floor level with clamp hangers. Maintain adequate clearance between raceway and piping.

D. Install raceways, boxes, enclosures, and cabinets as indicated, according to manufacturer's written instructions.

E. Avoid moisture traps; provide junction box with drain fitting at low points in raceway system.

F. Use conduit bodies to make sharp changes in direction, as around beams. Use hydraulic one-shot bender when field fabricated elbows are required for bends in metal conduit larger than 2 inch size.

G. Expansion:
   1. Provide suitable fittings to accommodate expansion and contraction where raceway crosses seismic and expansion joints. Install expansion fittings in the full open position if installed during a period of lowest expected temperature, and in the fully closed position if installed during a period of highest expected temperature. Install at proportionate intermediate position for intermediate temperatures.

H. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot water pipes. Install horizontal raceway runs above water and steam piping.

I. Install raceways level and square and at proper elevations. Provide adequate headroom. Group related conduits; support using conduit rack. Construct rack using steel channel; provide space on each for 25 percent additional conduits.

J. Complete raceway installation before starting conductor installation.

K. Use temporary closures to prevent foreign matter from entering raceway.

L. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portion of bends is not visible above the finished slab.

M. Make bends and offsets so the inside diameter is not reduced. Unless otherwise indicated, keep the legs of a bend in the same plane and the straight legs of offsets parallel.

N. Install exposed raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.

O. Run parallel or banked raceways together, on common supports where practical and make bends from same center line to make bends parallel. Use factory elbows only where they can be installed parallel; otherwise, provide field bends for parallel raceways.

P. Terminate rigid and IMC conduits in threaded hubs. Screw the raceway or fitting tight into the hub so the end bears against the wire protection shoulder. Use raintight sealing hubs.
with neoprene O-ring between exterior of enclosure and exterior half of hub where exposed to weather or other wet locations.

Q. Install pull wires in empty raceways. Use No. 14 AWG zinc-coated steel or monofilament plastic line having not less than 200-lb tensile strength. Leave not less than 12 inches of slack at each end of the pull wire. Test conduits required to be installed, but left empty, with ball mandrel. Clear any conduit which rejects ball mandrel.

R. Install raceway sealing fittings according to the manufacturer's written instructions. Locate fittings at suitable, approved, accessible locations and fill them with UL-listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings where conduits enter or leave hazardous locations, where conduits pass from warm locations to cold locations, such as the boundaries of refrigerated spaces and air-conditioned spaces, and other places indicated on the drawings or required by the NEC.

S. Stub-Up Connections: Use type of conduit described for stub ups from slab. Extend conduit through concrete floor for connection to freestanding equipment to a distance 6 inches above the floor and transition to Liquidtight flexible conduit. Provide grounding bushing at equipment end of Liquidtight flexible conduit. Connect equipment grounding conductor run with the serving branch circuit to this grounding bushing, the box, and the equipment ground connection point for the piece of equipment served.

T. Flexible Connections: Use maximum of 6 feet of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use Liquidtight flexible conduit in wet or damp locations. Install separate ground conductor across flexible connections.

U. Provide grounding connections for raceway, boxes, and components as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

V. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.

3.04 BOXES AND CABINETS

A. Provide boxes for splices, taps, wire pulling, equipment and fixture connections and where required by applicable codes and installation practices.

B. Locate boxes to maintain headroom and present a neat appearance. Locate to allow proper access.

C. Provide knockout closures to cap unused knockout holes where blanks have been removed.

D. Support all boxes rigidly and independently of conduit except where specifically allowed by the National Electrical Code. Use supports suitable for the purpose.

E. Pull and Junction Boxes:
1. Support independent of conduit.
2. Locate pull or junction boxes to limit conduit runs to no more than 150 linear feet of four (4) 90 degree bends between pulling points.

F. Provide covers for all boxes.

3.05 PROTECTION

A. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

B. Repair damage to PVC or paint finishes with matching touch-up coating recommended by the manufacturer.

3.06 CLEANING

A. Upon completion of installation of system, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.07 RECORD DOCUMENTS

A. Accurately record actual routing of underground conduits.

END OF SECTION 26 05 33
SECTION 26 05 53

IDENTIFICATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes identification of electrical materials, equipment, and installations. It includes requirements for electrical identification components including but not limited to the following:
   1. Buried electrical line warnings
   2. Identification labeling for raceways, cables, and conductors
   3. Warning and caution signs
   4. Equipment labels and signs

B. Refer to other Division 26 sections for additional specific electrical identification associated with specific items.

1.02 SUBMITTALS

A. Do not submit product data or shop drawings. Non-requirement of submittals is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

1.03 QUALITY ASSURANCE

A. Electrical Component Standard: Components and installation shall comply with NFPA 70 "National Electrical Code."

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Electromark - Wolcott, New York
   2. Ideal Industries, Inc.
   3. 3M
   4. Panduit Corp.
   5. Seton Name Plate Co.
   6. Thomas & Betts
   7. W. H. Brady, Co. - Signmark Division - Milwaukee, Wisconsin

2.02 ELECTRICAL IDENTIFICATION PRODUCTS

A. Underground Line Marking Tape: Permanent, bright-colored, continuous-printed, plastic, tape compounded for direct-burial service not less than 6 inches wide by 4 mils thick. Printed legend shall be indicative of general type of underground line below, such as "CAUTION - BURIED ELECTRIC LINE BELOW," "CAUTION - BURIED TELEPHONE LINE BELOW," etc. Tape shall have integral metallic facing or metallic core to allow locating buried tape with electronic detection equipment. Provide marking tape similar to Thomas & Betts NAF series.
B. Wire and Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable and conductor markers with preprinted numbers and letter.

C. Engraved, Plastic-Laminated Labels, Signs, and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8-inch thick for larger sizes. Engraved legend in black letters on white face and punched for mechanical fasteners.

D. Fasteners for Plastic-Laminated and Metal Signs: Self-tapping stainless steel screws or number 10-32 stainless steel machine screws with nuts and flat and lock washers.

E. Cable Ties: Fungus-inert, self-extinguishing, nylon one-piece, self-locking cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a minimum temperature range from minus 50 deg F to 350 deg F. Provide ties in specified colors when used for color-coding.

F. Identification Cable Ties: Same as "Cable Ties" above, except with integral tab of suitable size for marking requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.

B. Install identification devices in accordance with manufacturer's written instructions and requirements of NEC.

C. Identify Junction, Pull, and Connection Boxes: Code-required caution sign for boxes shall be pressure-sensitive, self-adhesive label indicating system voltage in black, preprinted on orange background. Install on outside of box cover. Legibly mark box covers with identity of contained circuits with contrasting color permanent marker.

D. Underground Electrical Line Identification: During trench backfilling, for exterior underground power, signal, and communications lines, install continuous underground line marking tape located 12" directly above each respective line.

E. Conductor Color Coding for Conductors Rated 600 Volts and Less: See Specification Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

F. Apply warning, caution, and instruction signs and stencils as follows:
   1. Install warning, caution, or instruction signs where required by NEC, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with Owner approved legend where instructions or explanations are needed for system or equipment operation. Install fiberglass signs or outdoor items.

G. Install identification as follows:
   1. Apply equipment identification nameplates of engraved plastic-laminate on each major unit of electrical equipment, including central or master unit of each electrical system. Except as otherwise indicated, provide single line of text, with 1/2-inch-high lettering on 1-1/2-inch-high label (2-inch-high where two lines are required), black lettering in white field. Text shall match terminology and numbering of the Contract Documents and shop
drawings. All nameplates shall be mounted with rivets or screws. Apply labels for each unit of the following categories of electrical equipment.

a. Electrical switchboards  
b. Motor starters  
c. Disconnect Switches  
d. Contactors  
e. Panelboards, electrical cabinets, and enclosures  

H. Apply labels of engraved plastic laminate for disconnect switches, circuit breakers, pushbuttons, pilot lights, motor control centers, and similar items for power distribution and control components above, except panelboards and alarm and signal components, where labeling is specified elsewhere. For panelboards, provide framed, typed circuit schedules with explicit description and identification of items served by each individual switch and circuit breaker.

I. Fusible Switches: Install fuse manufacturer supplied labels inside the door of the fusible switch indicating the proper type and fuse required for replacement.

END OF SECTION 260553
SECTION 26 28 13

FUSES

PART 1  GENERAL

1.01  SUMMARY

A. This Section includes the following:
1. Cartridge fuses rated 600-V ac and less.

1.02  SUBMITTALS

A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals will not be processed or reviewed. Non-required submittals is not to be construed as an allowance for substitutions and does not relieve the contractor from full compliance with the plans and specifications.

1.03  QUALITY ASSURANCE

A. Comply with NFPA 70 "National Electrical Code" for components and installation.
B. Listing and Labeling: Provide products specified in this Section that are listed and labeled by Underwriter's Laboratories for the specific use and purpose.
C. Single-Source Responsibility: All fuses shall be the product of a single manufacturer.

PART 2  PRODUCTS

2.01  MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide fuses by Bussmann Div., Gould-Shawmut

2.02  CARTRIDGE FUSES

A. Characteristics: NEMA FU 1 nonrenewable cartridge fuse, class as specified or indicated, current rating as indicated, voltage rating consistent with circuit voltage.
B. Cartridge Fuses: Cartridge fuses shall be as described below and shall have a minimum interrupting rating of 200,000 symmetrical amperes for the AC voltage at which they are rated.
C. Unless specifically shown otherwise on the drawings, provide UL class RK-1 dual element time delay fuses.

PART 3  EXECUTION

3.01  INSTALLATION

A. Install fuses in fusible devices as indicated. Arrange fuses so that fuse ratings are readable without removing fuse.
B. Fuses shall not be installed in equipment before the equipment has been set and anchored in its final position at the project site.

3.02 IDENTIFICATION

A. Install pre-printed labels from fuse manufacturer on the inside door of each fused switch to indicate exact fuse type and size for replacement information.

END OF SECTION 26 28 13
PART 1  GENERAL

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

1.02  SUMMARY
   A. This Section includes circuit and motor disconnects.

1.03  SUBMITTALS
   A. Submittals for approval by the Engineer are not required for this section. Unrequested submittals
      will not be processed or reviewed. Non-requirement of submittals is not to be construed as an
      allowance for substitutions and does not relieve the contractor from full compliance with the
      plans and specifications.

   B. Submit the following to the owner at the completion of the project in accordance with Conditions
      of Contract and Division 01 Specification Sections.
      1. Product data for products specified in this Section: Include dimensions, ratings, and data
         on features and components.
         specified in Division 01 and in Division 26 Section "Common Work Results for Electrical
         Systems."

1.04  QUALITY ASSURANCE
   A. Electrical Component Standards: Provide components complying with NFPA 70 "National
      Electrical Code" and which are listed and labeled by UL. Comply with UL Standard 98 and
      NEMA Standard KS 1.

   B. All switches 600 amperes and smaller shall be of the same manufacturer; switches larger than
      600 amperes shall also be products of one manufacturer, although not necessarily the same
      manufacturer as switches rated 600 amperes and smaller.

PART 2  PRODUCTS

2.01  MANUFACTURERS
   A. Manufacturers: Subject to compliance with requirements, provide products by the following:
      1. Square D Company
      2. General Electric
      3. Eaton Cutler Hammer
2.02 CIRCUIT AND MOTOR DISCONNECT SWITCHES

A. General: Provide circuit and motor disconnect switches in types, sizes, duties, features, ratings, and enclosures as indicated. Provide NEMA 1 enclosure except for outdoor switches, and other indicated locations. Outdoor circuit and motor disconnects shall be NEMA 3R enclosures, unless otherwise indicated, and shall be provided with raintight hubs. For motor and motor starter disconnects, provide units with horsepower ratings suitable to the loads.

B. Switches: Heavy duty, quick make, quick break switches, surface mounted unless otherwise noted, of classes and current ratings indicated. Unless indicated otherwise, provide 3 blade, with solid neutral when a neutral is provided.

C. High pressure contact switches shall be equipped with stored energy spring charged mechanism that provides high speed positive switching action independent of the speed at which the handle is operated. Switch blades shall be visible when the switch is in the OFF position and the door is open. Units shall be 100% rated.

D. Provide positive pressure, reinforced type Class R fuse clips for fusible switches 600 amps or less to prevent other than UL Class RK current limiting fuses. Provide for class L fuses for switches over 600A.

E. Switches shall have provisions for padlocking the enclosure in the closed position and another provision for padlocking the switch operator in the open and closed positions. It shall not be possible to open the switch enclosure with the switch operator in the closed position, except by means of a defeat mechanism located to be found by experienced and knowledgeable personnel only. The defeat mechanism shall not be obvious to an untrained person.

1. Lugs: Provide mechanical lugs and power-distribution connectors for number, size, and material of conductors indicated.

F. Service Switches: Shall be as above, but shall also be UL listed for use as service equipment under UL Standard 98 or 869.

G. Provide heavy duty pin and tumbler type padlock for each switch located in areas outside of locked mechanical and electrical rooms. Provide keying per Owner's requirements.

2.03 CIRCUIT BREAKERS

A. Distribution Circuit Breakers rated 400 amperes or higher Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet bus bracing requirement.


2. Provide electronic trip molded case circuit breakers. Provide with Micrologic type 5.0A trip units with L, S, and I, trip functions.

B. Distribution Circuit Breakers rated below 400 amperes shall be thermal-magnetic circuit breakers.

C. Branch circuit breakers shall be bolt-on type EDB for 600 volt, molded case, temperature compensated, quick-make, quick-break, with thermal-magnetic trip and be permanently bolted to bus bars. Minimum A.I.C. rating to match existing. Breakers that feed heating, air conditioning and refrigeration equipment shall be listed as “HACR” type.
PART 3 EXECUTION

3.01 INSTALLATION

A. Install enclosed switches and circuit breakers in locations as indicated, according to manufacturer's written instructions.

B. Install disconnect switches for use as local disconnect switches with motor driven equipment within site of the associated equipment.

C. Install enclosed switches and circuit breakers level and plumb.

D. Install wiring between enclosed switches and circuit breakers and control and indication devices.

E. Connect enclosed switches and circuit breakers and components to wiring system and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts according to equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening torques specified in UL Standard 486A.

3.02 NAMEPLATES

A. Provide a nameplate conforming with Section 26 05 53 "Identification for Electrical Systems" on every disconnect defining what the load that it serves or disconnects.

3.03 FIELD QUALITY CONTROL

A. Testing: Subsequent to completion of installation of electrical disconnect switches, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening and closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation, and for verification of type and rating of fuses installed. Correct deficiencies then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

3.04 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

END OF SECTION 26 05 53