## DESIGN & CONSTRUCTION GUIDELINES

### DIVISION 23  HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

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DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 00 00 GUIDELINE INTENT

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. This division serves as a design and construction guideline for the Professional Architect/Engineer (A/E) and Contractors performing mechanical services at the University of South Florida. This guideline is intended to establish the University’s standard of quality and is not a specification. The A/E shall develop the permit and construction documents in accordance with the intent of the guideline and as necessary to comply with the given project scope and/or program.

B. In some instances, a product is named to represent a minimum acceptable quality standard as a basis for the A/E. The intent is for the A/E to specify/schedule not less than three manufactures/models based on similar style, appearance & performance characteristics of the named product.

C. This guideline lists minimum material quality standards. Materials not contained here-in shall be selected by A/E based on application and where code allows.

D. Substitution requests shall be in writing to the USF Project Manager. Notification of substitution acceptance will be in writing; otherwise the substitute is not accepted.

1.2 DESIGN CRITERIA

A. Professional Engineer shall provide Contract Documents prepared in accordance with 61G15, Florida Administrative Code.


C. Appropriate ASTM, ANSI, UL, ASME and NFPA standards must be met and specified for materials.

D. The A/E is responsible for developing, documenting, and promoting technical discussion of proposed systems early in the project design phase. Early submittals are to include narrative technical discussion of system types, materials, and controls; including options, advantages, disadvantages, relative costs, and architect/engineer recommendations.

E. USF has invested into very energy efficient central chilled water and hot water systems to serve the campus. As such, the A/E shall utilize the Central Campus Chilled Water and Hot Water Systems as a basis for the project HVAC design. Other system types including direct expansion (DX) are not allowed unless an exception is requested and approved by FP&C and PPD. In order to obtain approval, the request shall be accompanied by a Life Cycle Cost Analysis (LCCA) building energy calculations showing the life cycle cost benefit to USF for the requested substitution. Refer to the Article 3 (Technical Applications) USF Professional Services Guideline (PSG) for the substitution request and submission requirements.

F. During the early concept/design phase, the A/E shall establish the project chilled water and hot water load for the project and review these loads with FP&C and PPD in order to determine that the central plant capacities are satisfactory to support the additional loads. If additional plant capacity and/or distribution infrastructure are necessary, they should be included as a basic part of the project scope.

G. The A/E shall ensure that all major decisions regarding system types, materials, and controls are determined and agreed to by owner/user by the end of design development phase; and
documented in the design development submittal. Costs are to be included in the A/E’s design development estimate of construction cost.

H. The A/E shall utilize an approved version of either Trane Trace, Carrier HAP or other pre-approved whole building 8760 hour simulation software for design modeling and performing Life Cycle Cost Analysis (LCCA) building energy calculations. The A/E shall provide the completed model in electronic file to the owner at the end of the design phase. Refer to the FP&C Professional Services Guide for additional LCCA requirements.

I. Engineering Assumptions
1. INDOOR DESIGN CONDITIONS (by season): Temperature, relative humidity. Cooling: 75 °F / 50 % RH. Heating: 70 °F.
2. OUTDOOR DESIGN CONDITIONS (by season): Temperature, humidity, wind direction and velocity. Note: Florida may be defined as a humid climate. See ASHRAE Fundamentals Handbook (latest year). Cooling: 92 °F DB / 77 % CWB. Heating: 36 °F.
3. Assumed or anticipated occupant categories, densities, activities, and use patterns (diversity factors) for each space or type of space in the building.
4. Assumed electrical load for light and equipment in occupied spaces used in HVAC load calculations.
5. Any and all special thermal and moisture loads.
6. Minimum outdoor air volume shall be calculated as required by Florida Building Code – Mechanical Ventilation or provide an ASHRAE 62 (latest edition) Alternative with appropriate Addenda.
   a. The Ventilation Rate Procedure (VRP) as described in FBC-Mechanical is a prescriptive procedure in which outdoor intake rates are determined based on space type application, occupancy level and floor area.
   b. The alternate method in ASHRAE 62 is the Indoor Air Quality method in which outdoor intake rates and other system design parameters are based on an analysis of contaminant sources, contaminant concentration targets and perceived acceptability targets. This method is not recommended for most applications on campus.
   c. Class of air assumptions for exhaust and recirculation air streams.

J. Laboratory HVAC
1. Building spaces with fume hoods and animal holding facilities typically are prohibited by code and good practice from recirculation of air conditioning air: 100 % outside air is required. Clean room "class" per ASHRAE must be determined and documented. Since 100 % outside air systems and other special systems are expensive to build, operate and maintain, and since the size and complexity of the systems create ample opportunity for design, contract, construction, initial start-up and noise problems, it is critical that the detailed design basis and costs be established and documented in early design submittals.
2. All 100 % outside air units shall be equipped with preheat coils.
3. The A/E shall design exhaust systems as necessary to meet or exceed the code requirements for laboratory spaces in accordance with NFPA 45.
4. Air exhausted from chemical fume hoods and other special local exhaust systems shall not be recirculated.
5. Energy conservation devices that could result in recirculation of exhaust air or exhausted contaminants shall not be used unless designed in accordance with ANSI/AlHA Z9.5, “Nonlaboratory Air”, or “General Room Exhaust,” Laboratory Ventilation.
6. Air exhausted from laboratory work areas shall not pass unducted through other areas.
7. Air from laboratory units and laboratory work areas in which chemicals are present shall be continuously discharged through duct systems maintained at a negative pressure relative to the pressure of normally occupied areas of the building.

8. Positive pressure portions of the lab hood exhaust systems (e.g., fans, coils, flexible connections, and ductwork) located within the laboratory building shall be sealed airtight or located in a continuously mechanically ventilated room.

9. Chemical fume hood face velocities and exhaust volumes shall be sufficient to contain contaminants generated within the hood and exhaust them outside of the laboratory building.

10. The hood shall provide containment of the possible hazards and protection for personnel at all times when chemicals are present in the hood.

11. Special local exhaust systems, such as snorkels or “elephant trunks,” shall have sufficient capture velocities to entrain the chemical being released.

12. Canopy hoods shall not be used in lieu of chemical fume hoods.

13. Only Class II, Type B2 biological safety cabinets listed by National Sanitation Foundation as meeting NSF/ANSI 49, Class II (Laminar Flow) Biosafety Cabinetry, shall be permitted to be used in lieu of chemical fume hoods, as determined by a qualified person.

14. Laminar flow cabinets shall not be used in lieu of chemical fume hoods.

15. Air exhausted from chemical fume hoods and special exhaust systems shall be discharged above the roof at a location, height, and velocity sufficient to prevent re-entry of chemicals and to prevent exposures to personnel.

16. Fume Hoods shall be variable position sash type. Two position sash fume hoods are not acceptable. A/E shall review fume hood selections, safeties and control integration features with USF Engineers prior to finalizing design concepts.

K. Janitor Closets

1. Designated use areas including housekeeping, custodial rooms, laundry areas, etc. shall comply with the following requirements:
   a. Provide minimum exhaust rate of 1.0 CFM/SF and stated pressure differential, with no air recirculation. The pressure differential with the surrounding spaces must be at least 0.02 inches of water gauge on average and 0.004 inches of water at a minimum when the doors to the rooms are closed.
   b. Self-closing doors on all spaces outlined above.
   c. Deck-to-deck partitions or hard-lid ceilings. Joints shall be sealed.

1.3 DRAWING REQUIREMENTS

A. Plans, sections, and isometric drawings shall be prepared for the required HVAC systems.

B. Drawings shall detail mechanical rooms and include section cuts in all directions as necessary to convey clearly all pipe elevations, crossings and the equipment connections/locations. Mechanical room minimum scale shall be 1/4 inch = 1 foot - 0 inch Drawings shall show location of pipes, electrical equipment, drains, hose bib, etc. All equipment service clearances shall be dimensioned. Detail air handlers including adequate number of sections, and coil and filter removal clearances, and access (including size) for coil cleaning, etc. Provision shall be made for shaft removal.

C. Drawings shall include detailed equipment layouts and shall show dimensions: equipment, clearance spaces, inertia bases, housekeeping pads, drains, invert level for all piping, detail of pipe welds, etc.
D. Drawings shall include flow diagrams, system descriptions and a piping and instrumentation diagrams detailing all piping, equipment, instruments, instrument loops, control interlocks. Interface for class/material change, annunciation inputs, control relays, manual switches, indicating lights, etc.

E. The flow diagrams shall show all equipment, names, and equipment tag names, all valves, all instruments/controls, pipeline identification, valve identification, all line size transitions, direction of flow, interface for class/material change, annunciation inputs, control relays, manual switches, indicating lights, etc.

F. System description shall include basis of design, operating modes (start-up, normal, shut down, emergency, etc.), description and performance ratings of major equipment, control concepts and control sequence.

G. Flow diagrams shall include all major equipment, capacities or ratings, names and identification number, bypass and recirculation lines, control valves, valves required for routing for all modes, pipe sizes, connection to other systems.

H. Drawings shall include detailed pipe support drawings. Pipe support drawings shall include all dimensions, materials, fabrication procedures, fastening methods, pipe saddles, etc.

I. Drawings shall include detailed equipment connections and shall show all pipe/sizes dielectric unions or flanges, line-size transitions, vibration isolators, strainers, isolating valves, control valves, and instruments including gage cocks, air vents including isolating valves; drains including isolating valves, etc.

J. Drawings shall include detailed equipment layouts and shall show dimensions for equipment, clearance spaces inertia bases, housekeeping pads. Drawing shall also include location of drains, invert level (bottom or top of pipe) for all piping shown on drawings. Detail of pipe welds shall be shown on drawings.

K. Drawings shall indicate pipe size vs. insulation thickness. Detail of pipe insulation shall include K-Value, method of installation, vapor banner details, insulation shield detail (where required).

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION (Not Used)
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 00 COMMON WORK RESULTS FOR HVAC

PART 1 – GENERAL

1.1 PERMITS AND INSPECTIONS

A. Follow USF Building Code Administration (BCA) requirements for permitting and scheduling inspections. Coordinate with USF BCA department.

B. Minor Projects - Contractor is responsible for all permitting and inspecting fees.

C. Major Projects - Coordinate with USF Project Manager for responsible party for permitting fees.

D. Minor Projects with USF approved Construction Manager (CM) - Coordinate with USF Project Manager and assigned Construction Manager for responsible party for permitting fees.

E. Obtain and adhere to the Universities Hot Work Permit for each instance in accordance with the BCA requirements.

1.2 COORDINATION

A. Visit the site included in the scope of work to ascertain existing conditions. Verify all dimensions and locations before proceeding with work in the area and prior to purchasing equipment.

B. Review and coordinate between all construction documents, all project specifications, and all sections in USF Design and Construction Guidelines. Notify USF Project Manager of conflicts or discrepancies prior to proceeding with work.

C. Locate all underground utilities required by the Sunshine Law prior to proceeding with work. Contact USF Project Manager to obtain latest USF Campus Utilities Map for the area in scope of work prior to proceeding.

D. Coordinate with USF Project Manager, USF Parking and Transportation, and USF Police Department for required lane closures and parking spaces closures minimum 72 hours prior to closures. Contractor is responsible for all closure barriers and signs subject to USF review and approval.

E. Isolation of Existing Utilities: Contract drawings shall include general notes requiring Contractor to coordinate and schedule any and all work impacting existing facilities with the USF PM at a minimum of two (2) week prior to the anticipated work. Utility isolation valves located in manholes on site or in existing buildings shall only be exercised by USF Physical Plant personnel. In many instances, underground isolation valves have not been able to close-off bubble tight. The contract documents shall include a contingency plan to test the valves prior to cutting into the system. If the valves do not hold adequately to allow Contractor to perform the tie-in, the USF PM shall be notified immediately. The Contractors test cut or drilled test hole in the top of pipe shall be patched by the Contractor with an approved method upon completion of the test.

1.3 SUBMITTALS

A. Submit one electronic copy of HVAC Submittals as a single bookmarked pdf. Include a table of contents, bookmark/tab manual based on specification chapters or sections.

1.4 SITE

A. All existing utilities shall remain in place unless otherwise noted on the contract documents.

B. Contractor shall restore back to original installation primary gear, primary feeders, utilities, irrigation, etc. damaged by the contractor in the area of demolition or construction.

C. Provide an erosion control plan addressing prevention, control, and abatement of water pollution to USF Project Manager for approval prior to proceeding with work.
D. Safety fencing shall be neon green. Orange or black safety fencing shall not be used.

E. Conduit trenches shall be backfilled completely to provide safe crossing by the end of work day or whenever the work zone becomes inactive.

F. Maintain access to side streets, drives, and sidewalks at all times during construction.

G. Existing pedestrian/sidewalk lighting and roadway lighting shall remain operational during all phases of the construction until new lighting is energized.

H. Construction Sites: Provide protective barriers around open HVAC trenches manholes. USF shall have clear vehicle access to these items at all times during construction.

I. HVAC manholes: Provide 10 feet square barricade around manhole cover. Manhole cover shall be accessible to USF at all times. Remove construction debris such as dirt, sod, ground cover, etc.

J. Temporary services protective barricades shall allow 3 feet clearance on sides and rear (or required by code if greater), and 5 feet clearance in front of equipment.

K. No construction materials or construction tools shall be stored within the protective barricades.

L. No construction vehicles or personal vehicles shall be parked over manhole covers.

M. Project site design and final site constructed conditions shall include clear vehicle access to all above mentioned equipment for maintenance.

N. Fenced Construction Sites: An access point agreed to by USF Project Manager and USF Physical Plant Department shall be provided to USF. Chains shall have USF Standard 2000 Padlock and site contractor pad lock daisy chained. Project is responsible to provide the USF Standard 2000 Padlock, coordinate with USF Project Manager and USF Physical Plant Department.

O. Areas where work is performed shall be kept clean of debris and materials and shall be cleaned at the end of each work day. Contractor is responsible to secure all tools and materials at all times.

1.5 WARRANTY

A. Contractor shall provide minimum 1 year warranty for all labor and materials, whether included or not included by equipment manufacturers. Contractor shall replace defective materials during the first year of warranty without additional compensation from USF.

B. Manufacturer warranties greater than 1 year, or where lengthier warranties are required in the project documents, or in USF Design and Construction Guidelines shall extend the standard 1 year warranty.

C. Warranty period shall begin on date of substantial completion.

1.6 MISCELLANEOUS

A. USF Furnished Equipment:
   1. Contractor shall be responsible for receipt from USF, storage after receipt, and installation if required.
   2. Verify equipment connection requirements prior to rough-in and ordering materials.
   3. Install equipment in accordance with manufacturer instructions.
   4. Maintain equipment until project is turned over to USF at Substantial Completion.

B. A/E for new construction and renovations or contractor for miscellaneous additions shall demonstrate that the existing services have the required additional capacity and can accommodate the load being added.
C. A/E for new construction and renovations or contractor for miscellaneous additions shall demonstrate that the existing services are at adequate depth to accommodate the minimum slope requirements for tie-in of new to existing services.

1.7 PROJECT CLOSE OUT

A. Submit one electronic copy and one hard copy of Operations Manual as a single bookmarked pdf. Include a table of contents, bookmark/tab manual based on specification chapters or sections.

B. Provide record documents (as-built) per USF FPC requirements. Coordinate with USF Project Manager. Record documents shall include updated as-built drawings. Submit working ACAD drawings (with bound Xref files) on disk or other approved memory storage device include separate folder or disk including pdf copies of each as-built drawing. Filenames shall include drawing number as reference.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 FIELD QUALITY CONTROL

A. Existing Utilities (CW, HW, Potable Water, Electrical, Communications, etc.) – The A/E shall survey the existing site conditions and review current utility plans (via FP&C) to evaluate needs for the project and locations below grade to avoid conflicts.

B. Do not operate air handling units (AHU’s) during building construction phases unless filtration media with a Minimum Efficiency Reporting Value (MERV) of 8 are used at each return air grill, as determined by ASHRAE 52 to protect ductwork during construction.

C. Seal all return air openings with plastic and close all return air dampers during construction. Protect fan motors, switches, equipment, fixtures and other items from dirt, rubbish and foreign matter. Do not operate AHU’s if the building is not clean or if dust can enter coils or fan housing and ductwork systems. Do not operate AHU’s if the building is not positively pressurized. Do not operate exhaust fans if their operation creates a negative building pressurization.

D. Monitor and maintain all filters, filter media and all related items during construction and replace all filtration media prior to occupancy prior to occupancy with specified filters with a minimum value of a MERV 8. Minimum MERV 13 filters are required to be installed in all air-handlers at Substantial Completion. Refer to SECTION 23 41 00 Particulate Air Filtration for additional requirements.

E. The use of sweeping compounds and cleaning products is required during construction clean up on a daily basis and a complete detailed final cleaning will be performed by a qualified subcontractor prior to HVAC final start up and commission to ensure a clean environment prior to the occupancy of the building. This will be required at the completion of each phase and start up prior to building turnover and occupancy.

F. Source Control: Use of materials such as adhesives, sealants, and paints shall be low VOC type and comply with LEED IEQ credit 4.1 and 4.2. Please make note that no material will be allowed onsite without prior approval and all material will be inspected and verified during the course of this project.

G. Pathway interruption: During construction, isolate areas of work to prevent contamination of clean or occupied spaces. Provide temporary barriers that contain the construction area.

H. Housekeeping: Keep interiors of duct and pipe systems clean and free from dirt, rubbish and foreign matter. Prevent dust, debris and foreign material from entering the piping and ductwork. Remove temporary labels, stickers, etc. from fixtures and equipment. Do not remove
permanent nameplates, equipment model numbers, etc. Remove debris, rubbish, left over materials, tools and equipment from work areas and site. Daily clean-up is required and will be strictly enforced. Final acceptance shall not be approved until site is cleaned.

I. Scheduling: All construction activities to be coordinated to minimize or eliminate disruptions of operations in occupied portions of the buildings.

3.2 COLOR CODING OR LABELING AND IDENTIFYING

A. The following band colors and letter designations shall be used:

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<thead>
<tr>
<th>DESCRIPTION</th>
<th>LABEL TEXT</th>
<th>LABEL COLOR</th>
</tr>
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<tbody>
<tr>
<td>HVAC Piping</td>
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</tr>
<tr>
<td>Condensate</td>
<td>Condensate</td>
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</tr>
<tr>
<td>Chilled Water Supply (CHWS)</td>
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<tr>
<td>Chilled Water Return (CHWR)</td>
<td>Chilled Water Return</td>
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<td>Condenser Water Supply (CWS)</td>
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<td>Condenser Water Return (CWR)</td>
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</tr>
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<td>Hot Water Return (HWR)</td>
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</tr>
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<td>High Pressure Steam 125psi</td>
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<tr>
<td>Medium Pressure Steam 50 psi</td>
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<tr>
<td>Low Pressure Steam 15psi</td>
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</tr>
<tr>
<td>Boiler Feed Water</td>
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<td>Boiler Fill Line</td>
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</tr>
<tr>
<td>Boiler Make-up Water</td>
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END OF SECTION 23 05 00
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 13 COMMON MOTOR REQUIREMENTS

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
   1. Motor controllers.
   2. Torque, speed, and horsepower requirements of the load.
   3. Ratings and characteristics of supply circuit and required control sequence.
   4. Ambient and environmental conditions of installation location.

B. Operation and Maintenance Data

1. Include assembly drawings, bearing data including replacement sizes, and lubrication instructions.

C. Comply with requirements in this Section except when stricter requirements are specified in HVAC equipment schedules or Sections.

D. Comply with NEMA MG 1 unless otherwise indicated.

E. Electrical Service: Refer to Section on Motor Control for required electrical characteristics.

F. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, Service Factor, Power Factor, efficiency.

PART 2 – PRODUCTS

2.1 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 °C and at altitude of 3,300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

C. Efficiency: All motors shall be NEMA Premium Efficient Electric Motors according to the latest Energy Independence and Security Act

PART 3 – EXECUTION

3.1 EXECUTION

A. After Test and Balance (TAB), full load amps/voltage shall be tagged on all air handlers and pumps motors and fan motors over 1 hp.

END OF SECTION 23 05 13
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 19 METERS AND GAGES FOR HVAC PIPING

PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. Drawings shall show location of all gages and meters. Detail of installation shall be shown on drawing. Detail shall include all valves, nipples, unions, thermometers, wells, material of construction, range of gages/meters, etc. All meter locations should be easily serviceable and not in the way of other maintenance needs of other equipment.

1.2 MATERIALS

A. The following meters (where applicable) shall be required on all projects, including garages:

1. Chilled and Hot Water – Onicon System 10 BTU Meter and Onicon Electromagnetic Flow Meters 3 inch pipe size and larger shall be F-3500 Insertion type unless otherwise noted on the reference USF website. For pipe sizes smaller than 3 inch, Electromagnetic Flow Meters shall be F-3100 In-line type unless otherwise noted on the reference USF website. For more information refer to Physical Plant Website: http://www.pplant.usf.edu/pdf/sys_arch.pdf or contact the USF Physical Plant Utilities Department. BTU meters shall be installed in mechanical rooms in accessible locations adjacent to the EEM. Coordinate data cabling with USF. Flow meters shall be installed on the supply piping.

2. Electric – Main Distribution Panel Meter with Itron Electric Meter, Form 9S (FM 9S) and Form 16S (FM 16S). Refer to Physical Plant Website: http://www.pplant.usf.edu/pdf/sys_arch.pdf.


4. All meters shall be connected to an Allen Bradley 1803 EEM Panel. Latest approved meters by Physical Plant may also be used. Refer to Physical Plant Website: http://www.pplant.usf.edu/pdf/sys_arch.pdf.

B. PRESSURE shall be read by a differential pressure (DP) gage, calibrated in “feet.” (DP gage has two inputs, one high pressure and one low pressure.)

C. PRESSURE GAGES shall be selected so that failure will relieve pressure to the rear of gage.

D. GAGES/METERS shall be selected to operate midway of their scale.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

1.3 EXECUTION

A. ALL GAGES/METERS shall be installed such that they can be read easily, i.e., grouped together and facing in the same direction.

B. METERS for measuring potable, chilled, and hot water BTU meters and gas shall be installed before the first point of use in buildings.

C. BTU meters and EEM panels shall be located in mechanical rooms at normal panel height with appropriate access clearances.
D. Install meters with appropriate distance from change in pipe direction and install with manufacturers recommended upstream and downstream straight length equivalents.
PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS FOR VALVES

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

B. All valves are to be rated at working Pressure of 200 psig, 250 °F minimum WOG, or greater if engineering design demands. Stems are to point vertically or horizontally and must be located for easy service or repair. A valve schedule showing details; number, size, type, material, etc. of all valves should be shown on the Drawings.

C. Provide Valve Pressure and Temperature Ratings not less than indicated and as required for system pressures and temperatures.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Check valves are to be Y-Pattern 200 psi, WOG, swing check. Two (2) inches and smaller are to be bronze body, integral seat with renewable bronze disc. Sizes larger than two (2) inches shall include bronze disc, stainless steel spring, and cast iron body.

B. Balancing Valves - For two (2) inches and smaller, use screwed bronze with Pointer and calibrated readout plate and machined orifice. For sizes larger than two (2) inches, specify flow meter with machined orifice and two (2) readout connections. Provide a valve with locks located five (5) pipe diameters up-stream of the orifice.

C. Valves in Insulated Piping shall include stem extensions to account for installed insulation thickness sufficient to allow full stem movement/rotation.

D. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

E. Provide the following above ground Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
   2. Handwheel: For valves other than quarter-turn types.
   3. Handlever: For quarter-turn valves NPS 6 and smaller [except plug valves].
   4. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

F. Valves in Insulated above ground piping: With 2-inch stem extensions and the following features:
   1. Ball Valves: Full port with extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

G. Provide the following above ground Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.
   2. Threaded: With threads according to ASME B1.20.1.
H. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.

I. Above ground Application: If valve applications are not indicated, use the following:
   1. Shutoff Service: Full port ball or butterfly valves.
   3. Throttling Control Valve Service: Belimo Pressure Independent Characterized Control Valves (PICCV). Refer to 230900 - Instrumentation and Control for HVAC for more information.

J. Above ground End connections:
   1. For Copper Tubing, NPS 2 and Smaller: Threaded ends.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Steel Piping, NPS 2 and Smaller: Threaded ends.
   4. For Steel Piping, NPS 2-1/2 and Larger: Flanged ends.

K. Below Ground Shutoff Service: Valves - Provide flanged 2-piece full port cast iron, stainless steel ball and stem, water, oil, gas, full close-off, 200 psi ball valves. Valves below ground shall be installed in concrete valve box with corrosion resistant hinged access lid properly designed for the traffic condition. Floor of valve box shall not exceed 4 feet deep. If piping to enter valve box is below 4 feet, piping elevation shall transition into and out of valve box with 45 degree fittings. Each valve shall be installed in valve box with orientation and position so handwheel is accessible from surface access opening via to allow for periodic exercising of valves.

PART 3 – EXECUTION

3.1 EXECUTION

   A. Locate valves for easy access and provide separate support where necessary.
   B. Install valves in horizontal piping with stem at or above center of pipe.
   C. Install valves in position to allow full stem movement.
   D. Install chainwheels on operators for ball, butterfly, gate, globe, and plug valves NPS 4 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.
   E. Provide non-conducting dielectric connections wherever jointing dissimilar metals.
   F. Install unions downstream of valves and at equipment or apparatus connections.

END OF SECTION 23 05 23
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 29 HANGERS AND SUPPORT FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Detail of all hangers/supports/anchors for equipment, piping, ductwork, etc. shall be shown on drawings. Detail shall include size(s) and material of hangers/supports, fastening details, anchoring details etc. Spacing of hangers/supports shall be shown on drawings.

B. Pipe work supports/hangers shall be designed as per the latest edition MSS-58 and MSS-69. (MSS - Manufacturers Standardization Society)

C. Ductwork supports/hangers shall be designed as per the latest edition of SMACNA - HVAC Duct Construction Standard.

D. Design hangers without disengagement of supported pipe.

E. General Locations: Steel pipe hangers, miscellaneous steel supports, hardware, bolts, washers, nuts, screws, etc., shall be hot dipped galvanized with a minimum of 1.50 oz/ft on all sides and all field cuts shall be zinc coated.

F. Located in Harsh and/or Corrosive Environments: Pipe hangers, equipment supports, miscellaneous structure components, hardware, bolts, washers, nuts, screws, etc., shall be non-metallic polyester resin, vinyl ester resin, fiberglass, glass reinforced polyurethane or 316 stainless steel.

G. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

H. Provide an adequate and complete pipe support system using approved hangers and supports complete with necessary attachments, shields, inserts, bolts, rods, nuts, washers, and other accessories. Shields shall be a minimum of 12 inches long and of sufficient strength to ensure pipe hangers do not cut into or compromise the insulation integrity.

I. Provide adequate and complete pipe support system using hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units. Provide thermal expansion calculations for each system and component subject to stresses

PART 2 – PRODUCTS

2.1 MATERIALS

A. Unless otherwise indicated, factory fabricated hangers, supports, clamps, saddles, shields, and attachments shall comply with MSS requirements for the type or size installation, and comply with manufacturer’s published product information. Hangers, supports and anchors shall be sized properly to include insulation.

B. Hangers shall be isolated from piping to prevent contact with dissimilar metals.

C. Whenever mechanical equipment rooms are located within or immediately adjacent to the occupied building, vibration dampening hangers and supports shall be specified.

PART 3 – EXECUTION

3.1 EXECUTION

A. HANGERS/SUPPORTS shall be installed true vertical or horizontal.
B. Installation of hangers, supports, anchors, etc., shall be accomplished after required building structural work is completed. Where piping or equipment is to be suspended from concrete construction, approved concrete inserts shall be set in form work to receive hangers. Hangers suspended from metal or other roof deck are not permitted. Explosive driven fasteners and drilled concrete insets are not permissible.

C. Spacing attachments, supports, hangers, etc., are to be installed in accordance with MSS-69. Add additional attachments and supports where required for concentrated loads including changes in direction, fittings, and joints.

D. Piping shall be supported so that no piping weight (live or dead) load is transmitted to pump, equipment, chiller or to other equipment connections. Hangers and supports are to allow controlled movement of piping and to permit freedom of movement between anchors.

E. Vertical piping shall be anchored to building with two point bearing. Pipe covering and insulation protection shields/saddles shall to be used on all insulated piping.

END OF SECTION 23 05 29
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 48 VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 -- GENERAL

1.1 PERFORMANCE REQUIREMENT

A. Contract drawings shall list each piece of equipment/machinery minimum static deflection.

B. Contract drawings shall list the type of isolator to be used for each piece of equipment/machinery.

C. Design noise level for each space shall be listed in the drawings and/or specifications.

D. Whenever mechanical equipment rooms are located within or immediately adjacent to the occupied building, vibration dampening hangers and supports shall be specified.

E. All motor driven equipment over 2 h.p. shall be provided with vibration isolation.

F. All equipment/machinery isolators shall be designed at a minimum natural frequency of six (6) times lower than the driving frequency of the equipment/machinery.

G. Structures shall have a minimum natural frequency of three (3) times the driving frequency of the supported equipment/machinery.

H. Inertia base shall be used for all fans operating at four (4) inches static pressure and above or with motors over 40 h.p. and all base mounted pumps over 15h.p. Engineer shall analyze all rotating equipment and list all which required inertia bases. This list shall be shown on drawings at Advance Schematic phase.

I. Inertial base shall be sized for a minimum of 1.5 times equipment weight but not less than six (6) inches high.

J. Vibration isolators e.g. flex connections etc. shall be used at all connection points of all vibration generating equipment.

K. All roof top equipment installation shall be analyzed and roof curb isolation rails specified if necessary. Except for fans, all roof-top equipment shall be approved, in writing, by the University.

L. A/E shall make recommendation for floating floors where necessary.

M. Internally isolated fans in air handlers are acceptable when approved by A/E.

N. SHOP DRAWINGS: Shop drawings shall include as a minimum: Drawing(s) of equipment detailing: operating weight, stiffness of each isolator, mark of each isolator (color coding of each isolator preferred), center of gravity of equipment/machinery, static deflection specified vs static deflection submitted; and static and dynamic load on each isolator.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Springs shall be used for all static deflections greater than two (2) inches.

B. Springs shall be used in conjunction with isolating elastomer.

C. Inertial bases fill shall be reinforced 3,000 psi concrete.

D. All isolators outdoors shall be protected. Steel points shall be hot dipped galvanized. Springs and hardware shall be cadmium plated.
3.1 EXECUTION
   A. Install isolators to ensure the integrity of isolators is not compromised i.e. no short-circuiting exists.
   B. For critical areas, the manufacturer shall inspect isolated equipment and submit report including static deflection.

END OF SECTION 23 05 48
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 53 IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENT

A. All Mechanical drawing symbols used shall be in accordance with standards of accepted practice.

B. All equipment and piping including associated electrical devices, shall be labeled and tagged in accordance with the University’s guidelines.

C. Equipment tags and labels shall be permanently fastened to the major equipment. Labels shall indicate a list of regular maintenance replacement components (i.e., filters, belts, etc. include quantities and sizes).

D. Label Content: Include caution and warning information, plus emergency notification instructions.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Labels, tags and signage shall be letter color coded according to service, and background color appropriate for the application and size for ease of readability. Comply with ANSI A13.1.

B. Labels shall be made of durable long lasting materials able to withstand temperatures up to 160 °F.

C. Provide Valve Schedules in mechanical rooms to identify valves: For each piping system, on 8-1/2 by 11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses. Copy of the valve-tag schedule shall be included in operation and maintenance data.

D. Access Panels - Access panels are required in each situation where items requiring maintenance are located above a concealed ceiling. Access panel sizes shall be suitable for application. Access panel locations shall be indicated on contract drawings.

PART 3 – EXECUTION

3.1 EXECUTION

A. Locate tags, signage and equipment labels where accessible and visible.

B. Install identifying devices before installing acoustical ceilings and similar concealment.

C. Engraved signs and labels shall be permanently attached with Stainless-steel rivets or self-tapping screws unless approved otherwise.
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 05 93 TESTING, ADJUSTING AND BALANCING (TAB) FOR HVAC

PART 1 — GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. TAB Agency shall submit TAB Plan to A/E for approval. Plan shall include locations of all measuring points, instruments to be used, measurements to be made, method for TAB, etc.

B. Where a Commissioning Authority is employed, the TAB Plan shall be submitted to this Authority for approval.

C. The TAB effort shall be as coordinated with the Contractor and performed as scheduled to produce the TAB report which shall be used during the functional performance testing. A copy of the final TAB report should be submitted to the owner and A/E no later than at the time of substantial completion.

PART 2 — PRODUCTS (Not Used)

PART 3 — EXECUTION

1.2 EXECUTION

A. TAB Agency shall verify all controls and perform calibration of flow measuring stations.

B. TAB results shall be included in the As-Builts drawings which are included in the Operation and Maintenance Documentation required at Substantial Completion.

C. TAB shall include building pressurization measurements and summation of the ventilation air, exhaust air, etc. to the building pressurization observations.

END OF SECTION 23 05 93
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 07 00 HVAC INSULATION

PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENTS
   A. Design insulation systems for all piping, ductwork and equipment in accordance with the requirements set forth here-in and no less than the minimum per the latest Energy Code requirements. Insulation thickness/K-Value shall be designed to prevent condensation under all operating conditions especially in a hot humid environment.

1.2 DEFINITIONS
   A. Hot Surfaces - normal operating temperatures of 100 °F or higher.
   B. Cold Surfaces - normal operating temperatures of 75 °F or less.
   C. Dual Temperature Surfaces - normal operating temperatures that vary from hot to cold.

1.3 APPLICATIONS
   A. General: Materials and thicknesses are specified in schedules at the end of this section.
   B. Interior, Exposed Piping Systems and Concealed Piping Systems: Unless otherwise indicated, insulate the following piping systems:
      1. Chilled Water.
      2. Heating Hot Water.
      3. Refrigerant suction lines.
      4. Condensate waste piping. Copper condensate pipe on roof does not require insulation.
   C. Exterior, Exposed Piping Systems: Unless otherwise indicated, insulate the following piping systems:
      1. Chilled Water.
      2. Heating Hot Water.
      3. Refrigerant suction lines.

PART 2 – PRODUCTS

2.1 MATERIALS
   A. Ductwork Insulation (Unless otherwise indicated, insulate the following duct systems)
      1. Interior concealed outside air, top of supply air devices, supply and return air Ductwork – Nominally 2.2 inch thick, 0.75 PCF fiberglass wrap and foil scrim kraft jacket with minimum installed insulation value of R-6.
      2. Mechanical rooms, interior exposed outside air, supply and return air Ductwork – Nominally 1.5 inch thick, 1.5 PCF fiberglass rigid board and foil scrim kraft jacket with minimum installed insulation value of R-6. Similar to CertaPro Commercial Board - CB150. Insulation requirements for exposed ductwork within interior conditioned spaces shall be evaluated and specified by the A/E.
      3. Exterior dual wall outside air, supply and return air Ductwork - Nominally 1.5 inch thick 1.5 PCF fiberglass rigid liner board securely attached and sandwiched within the solid
galvanized interior liner and the aluminum exterior jacket with minimum installed insulation value of R-6.

4. Insulation R-Values/insulation thickness shall be increased to reflect the wider temperature differences to prevent surface condensation and/or heat loss as determined by the A/E.


<table>
<thead>
<tr>
<th>MATERIALS</th>
<th>APPLICATION</th>
<th>THICKNESS (INCHES)</th>
<th>VAPOR BARRIER REQUIRED</th>
<th>FIELD APPLIED JACKET</th>
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<tr>
<td>Interior Concealed Ductwork</td>
<td>Duct Wrap</td>
<td>Outside Air Plenums</td>
<td>2.2</td>
<td>Yes</td>
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<tr>
<td>Interior Exposed Rectangular Ductwork</td>
<td>Rigid Board</td>
<td>Outside Air Plenums</td>
<td>1.5</td>
<td>Yes</td>
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<tr>
<td>Interior Exposed round Ductwork</td>
<td>Duct Wrap</td>
<td>Outside Air Plenums</td>
<td>2.2</td>
<td>Yes</td>
</tr>
</tbody>
</table>

B. Pipe Insulation (Above Ground)

1. Cellular Glass Pipe Insulation - Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells similar to Pittsburgh Corning Corporation; Foamglas. Thermal Conductivity: 0.29 BTU-in/hr. ft² ⁰F @ 75 ⁰F with maximum flame spread index of 25 and a maximum smoke developed index of 50.

2. Flexible Closed Cell Elastomeric Thermal Preformed Pipe Insulation – Thermal Conductivity: 0.25 BTU-in/hr. ft² ⁰F @ 75 ⁰F, thick similar to Armaflex with maximum flame spread index of 25 and a maximum smoke developed index of 50.

3. Glass Fiber Preformed Pipe Insulation with factory applied ASJ similar to Knauf 1000 Pipe Insulation with maximum flame spread index of 25 and a maximum smoke developed index of 50. Thermal Conductivity: 0.23 BTU-in/hr. ft² ⁰F @ 75 ⁰F.


<table>
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<tr>
<th>MATERIALS</th>
<th>PIPE SIZE (NPS)</th>
<th>THICKNESS (INCHES)</th>
<th>VAPOR BARRIER REQUIRED</th>
<th>FIELD APPLIED JACKET</th>
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</thead>
<tbody>
<tr>
<td>Interior Concealed and Exposed Chilled Water</td>
<td>Cellular Glass</td>
<td>All</td>
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<tr>
<td>Outdoor Aboveground Chilled Water</td>
<td>Cellular Glass</td>
<td>All</td>
<td>3</td>
<td>Yes</td>
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<tr>
<td>Interior Concealed and Exposed Heating Hot Water</td>
<td>Glass Fiber</td>
<td>1/2 to 2</td>
<td>1-1/2</td>
<td>Yes</td>
</tr>
<tr>
<td>Outdoor Aboveground Heating Hot Water</td>
<td>Cellular Glass</td>
<td>All</td>
<td>2</td>
<td>Yes</td>
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<tr>
<td>Interior / Exterior Refrigerant Suction Lines</td>
<td>Flexible Elastomeric</td>
<td>5/8 to 2-1/8</td>
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<td>No</td>
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</table>
PART 3 – EXECUTION

3.1 GENERAL

A. Armaflex shall not be split for installation.
B. Insulation shall not be applied until systems are cleaned and satisfactorily tested. All piping and other work to be insulated shall be free of building debris, flux, and foreign material. Duct shall be clean, dry, and free of rust prior to installation of insulation.
C. Insulation and vapor barrier shall be continuous through sleeves, walls penetrations, openings and hangers.
D. Installation shall be in strict accordance with manufacturer’s instructions.
E. Flanges, valves, vessels and fittings shall be insulated and finished the same as pipe. Even if the manufacturer’s standards for pre-insulated piping allows gaps in the continuity of the insulation, such shall be specified to be made continuous.
F. Continuous unbroken vapor barrier jackets are required on cold surfaces. Special attention is to be given to prevent condensation and subsequent deterioration of piping.
G. Insulation shall be protected at supports and hangers. Shields or saddles adequate to support the weight of pipe without crushing the insulation shall be provided.
H. Foam plastic insulation is not permitted within buildings or in overhangs or within five (5) feet of the building perimeter.
I. Insulation for pumps, heat exchangers, and similar equipment, that may require periodic inspection or maintenance, shall be fabricated in easily removed sections.
J. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
K. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
L. Keep insulation materials dry during application and finishing.
M. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
N. Install insulation with least number of joints practical.
O. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
P. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 08 00 COMMISSIONING OF HVAC

PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Functional Performance Testing of the building HVAC and DDC Controls shall be a basic part of the A/E scope of services necessary to verify and validate the proper construction and operation of the systems according to the signed/sealed construction documents and per the Engineer of Records design intent.

B. A/E shall discuss which level of commissioning is desired by USF prior to entering into contract with USF for professional services. The Commissioning Authority should be selected before award of contracts.

C. If USF chooses to hire a third party Commissioning Authority for Building Commissioning (including Functional Performance Testing of the building HVAC and DDC Controls), the A/E shall support the commissioning effort to the extent necessary for interpretations of the design intent and to uphold their Engineer of Record responsibilities.

D. The A/E and Commissioning Authority shall use the latest edition of ASHRAE Guideline as the basis for Building HVAC and DDC Controls Commissioning.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 EXECUTION

A. Once the level of commissioning is determined, the A/E shall develop the specifications incorporating specific language supporting the commissioning process. The specifications shall include the contractor requirements for coordination, scheduling, submissions, manpower and support of the commissioning effort. The A/E shall coordinate design documents with the Commissioning Authority throughout the design period.

B. The A/E and Contractor shall coordinate submittal documents with the Commissioning Authority throughout the construction period.

C. The A/E and/or Commissioning Authority shall work with the owner to develop the Operation and Maintenance requirements for installed systems and coordinate these requirements with the Contractor.

3.2 OPERATION AND MAINTENANCE DOCUMENTATION

A. Operation and Maintenance Documentation shall be submitted at substantial completion. Refer to Project Close Out requirements in Section 23 05 00 Common Work Results for HVAC for. A/E shall determine timelines for draft submittal to ensure that A/E and Owner review comments are incorporated in the final documents.

B. A/E shall use the latest edition ASHRAE Guideline as a basis for preparation of specifications for O&M Documentation.

C. Reduced copies eleven (11) inches by seventeen (17) inches of “As-Built” Drawings shall be included.

END OF SECTION 23 08 00
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. Provide a DDC Computerized Energy Management control system to facilitate the air handling unit schedule and temperature and humidity controls.

B. All new facility to be connected to the owners central control center using the Ethernet network and BACnet protocol. All BACnet devices shall be interconnected on a common BACnet IP subnet. In order to avoid addressing conflicts, a specific range of BACnet Device Instances and Network Numbers shall be assigned for each building.

1. Device Instances

A unique Device Instance for each BACnet Device shall be assigned within the following format:

- XXXYYYY, Where:
  - XXX is the building number per the Facilities Planning and Construction Campus Map.
  - YYYY is a unique number for each device within the building. First is the number of the building controller. The second is the MS/TP LAN number. The third and fourth is the controller number and these usually match the MS/TP MAC address numbers. The Environmental Controls Department can assist in coordinating these numbers.

2. Network Numbers

A unique network number for each BACnet Network utilized (i.e. Ethernet, MS/TP, PTP) shall have a number assigned within the following format:

- XXXYY, Where:
  - XXX is the building number per the Facilities Planning and Construction Campus Map.
  - YY is a unique number for each network within the building. The Environmental Controls Department can assist in coordinating these numbers.

3. IP Network Number

All BACnet devices shall be interconnected on a common BACnet IP subnet. All devices communicating on this network will share the same BACnet IP Network Number. This number shall be 101.

C. Control contractor shall complete all sensing and control installations including electrical and electronic components.

1.2 DRAWINGS

A. The A/E shall provide control drawings on the bid documents that show the following:

1. Sequence of operation.
2. All sensors location on all equipment.
3. Type of points (Analog / Digital, Input / Output).
4. Control Valves.
5. Control dampers.
6. Air Monitor sizing.

B. The A/E shall request from the contractor to submit the following items as a minimum:
1. Provide copies of all submittal data.

2. An overall system interconnecting diagram showing all remote panels (PCs, Field Panels, and LAN devices), and power/surge protection locations and Uninterrupted Power Supply (UPS).

3. Distributed panel locations (site and/or building plan, as appropriate to identify physical locations).

4. Valve and damper schedules showing size, CV, close-off pressure, configuration, capacity, Manufacturer and location.

5. Data sheets for all hardware and software control components.

6. Thermostat/sensor locations.

7. A description of the methodology used to keep graphics files on various PC terminals updated and consistent with one another. (Remote computer graphics vs. site computer)

8. A detailed point-to-point diagram of circuitry of all DDC panels. Submit on a per distributed panel basis. Typical are accepted, provided all applicable units are listed and the units are identified.

9. A list of connected data points, including connected control unit and input or output devices.

10. A detailed Sequence of Operations.

11. Detailed documentation on the specific field equipment to be supplied by the Controls Contractor shall be submitted and approved prior to installations; including, but not limited to, actuators, valves, temperature sensors, surge protection, and damper operators.

12. All schemes and methods proposed to provide lightning protection for the DDC system, entering and leaving each building shall be submitted for review and approval.

13. The Contractor shall develop project specific verification forms for all control equipment (AHU, FCU, VAV, CPU, Printer, Chiller, etc.) and submit them to the Engineer for approval prior to use. Once they are approved, the Contractor is responsible for completing the columns identified for installed information and inspection.

14. System verification forms are to be completed by the Contractor and verified by the A/E.

15. A verification form is to be completed for each individual component or equipment requiring verification.

16. The Contractor shall submit completed reports immediately after tests are performed.
   a. Record all data gathered on site on approved verification forms.
   b. Provide the Engineer with original of each completed verification form.
   c. Maintain a photocopy on site of data taken during starting and testing period.
   d. Maintain one copy of all final starting, testing, balancing and adjusting reports on site up to the issue of the interim certificate for reference purposes.

17. All final verification forms are to be submitted in word or excel format.

18. Submit to Engineer for review and approval.

19. Make corrections and re-submit as requested by the Engineer.

20. The Contractor shall submit brief step-by-step description of entire starting procedure to allow the Engineer to repeat starting at any time.

21. The Contractor shall provide the required shop drawing information and verify the correct installations and operation of each item on system verification forms. This will include information such as equipment/component code, location and nameplate data.
22. The systems verification cannot take place before all related components have been verified as correct.

23. Prior to startup and testing of the DDC components or systems, prepare a schedule for the required testing. Review schedule with the Engineer.

24. Provide sufficient notice (minimum seven days) prior to commencing tests.

25. Engineer may witness all or any portion of testing and startup procedures performed by the Contractor.

26. The Contractor shall be present for all tests.

C. USF shall review submittals prior to the Engineer approval.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Subject to compliance with terms and conditions each manufacturer agreed to provide, the following manufacturers are acceptable:

1. Tampa Campus
   a. Trane-Summit (Native BACNET System)
   b. Alerton (Native BACNET System)
   c. Johnson Controls (Native BACNET System)
   d. KMC (Native BACNET System)

2. Regional campuses may specify alternate manufactures or refer to vendors listed below. Alternate vendors for the Tampa campus shall be approved by the Campus Mechanical Engineer and Environmental Control/Physical Plant.
   a. Sarasota Campus
      i. Alerton-Bacnet
      ii. ALC - Bacnet
   b. St. Petersburg Campus
      i. Trane-Summit Tracer (Bacnet)
      ii. Alerton-Bacnet

B. COMMUNICATIONS NETWORK, PC

1. Furnish a totally native BACnet-based system, including a Microsoft compatible operator's workstation. The operator's workstation, building controllers, application controllers, and input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2008, BACnet. In other words, workstations and controllers, including unitary controllers, shall be native BACnet devices. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed under other sections.

2. Each Building shall have a Global Controller with a Ethernet port that supports BACnet over IP protocol and as many MS/TP networks needed to provide for zone-by-zone control of space temperature and humidity as specified.

3. Building controllers shall include complete energy management software, including scheduling building control strategies with optimum start and logging routines. Energy management software and firmware shall be resident in field hardware and shall not be dependent on the operator's terminal. Operator's terminal software is to be used for access
to field-based energy management functions only. Provide zone-by-zone direct digital logic control of space temperature, scheduling, runtime accumulation, equipment alarm reporting, and override timers for after-hours usage.

4. Operator's workstation software shall use Microsoft Windows Server 2003 or later operating system. The Energy Management and Control System (EMCS) application program shall be written to communicate specifically utilizing BACnet protocols. Software functions delivered on this project shall include password protection, scheduling (including optimum start), alarming, logging of historical data, full graphics including animation, after-hours billing program, demand limiting, and a full suite of field engineering tools including graphical programming and applications. Systems using operating systems other than that described above are strictly prohibited. Software required to program application specific controllers and field level devices and controllers will be left with the owner. Software passwords required to program and make future changes to the system will also become the property of the owner. Software required to make any program changes anywhere in the system, along with scheduling and trending applications, will be left with the owner. Software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of the owner. Software required for field engineering tools including graphical programming and applications will be left with the owner. Software passwords required to program and make future changes to field engineering tools, including graphical programming and applications will be left with the owner. In addition, provide the monitoring of the following systems:

a. Lighting control monitors.

b. Building systems monitors as scheduled or required.

C. AUXILIARY CONTROL DEVICES

1. AUTOMATIC CONTROL DAMPERS AND OPERATORS

a. Automatic control dampers shall have interlocking blades and frames. Dampers shall be designed and constructed so that the blades, frames, and linkage mechanism shall present a rigid assembly with free and easy action. Dampers shall be of galvanized steel blades and welded steel frame (stainless steel for units within two (2) miles of salt water bodies). The damper bearings shall be brass or oil impregnated nylon with brass bearing shafts. Where the damper blades are installed in a vertical position, a thrust type ball bearing shall be provided for the lower bearing. All bearings in ducts or casings to the outside shall have the top and bottom edges on both ends trimmed with replaceable neoprene seal fastened in an approved manner, so as to be practically air tight when closed. Closed dampers shall have leakage of not more than one-half (1/2) percent at four (4) inches of water column (10.2 cm) static pressure and 2,000 feet per minute velocity.

b. Leakage and flow characteristics of dampers shall be submitted to the Engineer to specify performance. Test leakage reports shall be in accordance with AMCA standard 500-75.

c. When dampers are located at fan discharge they shall be designed to operate properly without fluttering, at velocities up to 4,000 fpm and against a static pressure differential developed by the fan. Maximum deflection shall be no more than 1/50 of the unsupported span distance. Each automatic damper or section of damper if too large for one motor shall be operated by the required number of modulating motors. The motors shall be of the proper size required to operate the damper with uniform and gradual movement and shall return the damper to the same position for a given signal during an opening or closing movement of the damper. Damper operators shall be of the proportional type capable of accepting 0-10 volts or 4-20 ma control signal and 2-10 VDC feedback signal. The type of operator input signal will be a function of the DDC control panel output.
d. Damper operators shall include spring return.

e. Approved damper manufacturers are: Metalaire, Ruskin, and Vent products.

f. The Control Contractor shall furnish all the controlled dampers of the type and sizes indicated on the Drawings for installation by the Sheet Metal subcontractor or the Mechanical contractor.

g. All two-position control dampers shall be sized for minimum pressure drop, at the specified duct size.

h. All modulating dampers shall be sized for an effective linear air flow control characteristic within the angle of rotation and maximum pressure drop specified. Information shall be provided to the Sheet metal subcontractor for determining the proper duct reductions or baffles used.

i. Damper frames shall not be less than 13 gauge galvanized steel, formed for extra strength, with mounting holes for enclosed duct mounting.

j. All damper blades shall be of not less than 16-gauge galvanized steel formed for strength and high velocity performance. Blades on all dampers must not be over eight (8) inches in width. Blades shall be secured to one half (1/2) inch diameter zinc plated axles by zinc plated bolts and nuts. Blade side edges shall be sealed off against spring stainless steel seals. Teflon coated thrust bearings shall be provided at each end of every blade to minimize torque requirements and insure smooth operation. All blade linkage hardware shall be constructed of corrosion resistant, zinc plated steel and brass.

k. Dampers shall be suitable for operation between 20°F and 150°F. The Control Manufacturer shall submit leakage and flow characteristics plus a size schedule for all controlled dampers.

l. Dampers shall be of the parallel blade design for two-position service and opposed blade design for modulating service.

m. Approved damper operator manufacturer is: Belimo.

2. AUTOMATIC CONTROL VALVES AND OPERATORS

a. The A/E shall specify Two-Way Belimo PICCV control valves for control of all Chilled Water and Heating Hot Water Hydronic Coil systems unless otherwise reviewed and approved by USF Physical Plant. Chiller/Boiler Plant Control valves shall be Belimo SY industrial actuators for automatic butterfly valve applications.

b. PICCV valves are preferred for control valves, and only under special circumstances, and as approved by Physical Plant, may non-PICCV control valves be considered. Upon receipt of this exception for a specific project or application, control valves may be characterized ball valves or globe style valves provided they comply with the below control valve and actuator requirements.

c. The Control Contractor shall furnish all the control valves of the type indicated on the drawings for installation by the Mechanical Contractor.

d. All modulating straight-through water valves shall be provided with equal percentage contoured throttling plugs. All modulating three-way mixing valves shall be provided with linear V-port plugs such that the total flow through the valve shall remain constant regardless of the valve's position. All diverting valves shall have two V-port plugs.

e. Valves 2-inches and smaller shall have brass or bronze bodies with screwed ends. Valves 2 1/2-inches and larger shall have iron bodies brass or bronze trimming with flanged ends. Valves shall be factory rated to withstand the pressures encountered. Valves shall have stainless steel stems and spring loaded Teflon packing.
f. Air handling unit water valves shall be sized for a pressure drop equal to the coil they serve but not to exceed 5 psi. Valves shall have replaceable seats and discs. Provide pressure drop at half flow with submittals.

g. All automatic control valves shall be fully modulating type unless specified otherwise by the project engineer.

h. All control valves shall be designed to fail as follows:

i. Cooling - Fail fully open to coil.

j. Heating - Fail fully closed to coil.

k. Each valve operator shall be 4-20ma type, with spring return or manual position override and feedback.

l. Valves actuators shall be mounted vertical only.

m. Valves and Actuators shall be Belimo.

3. CURRENT SWITCHES: Provide a solid state switch which when the current level sensed by the internal current transformer exceeds the adjustable trip point. Internal circuits are to be totally powered by induction from the line being monitored. Provide a zero off-state leakage in the solid-state relay output, while switching both AC and DC circuits. Provide an LED that will show three pieces of information. (Rapid Flashing-switch is tripped, Slow Flashing-current is present but below the trip point and no Flashing-current is either off or below the bottom of the range) and permits setting the trip point adjustment prior to system connection.

4. DIFFERENTIAL PRESSURE SWITCHES: Differential pressure switches shall be furnished as indicated by the sequence for status purposes for either air or water applications. Provide single pole double throw switch with fully adjustable differential pressure settings. The switch shall have a snap-acting Form C contact rated for the application. The switch contact shall be rated for 5 amps at 120 volts as a minimum. Units shall be selected for ranges consistent with the application and shall be submitted for the Engineer’s approval. Dwyer and Cleveland products are acceptable manufacturers.

5. ELECTRONIC TEMPERATURE SENSORS:

a. Temperature sensors shall be thermistors or 100 Ohm platinum RTD. Sensors shall be calibrated to less than or equal to a 1/4 degree F resolution for the specific application. Substitutions must be approved by the Engineer. All sensors to be field verified as correct.

b. Provide twisted pair lead wires and shield for input circuit or as otherwise required by the manufacturer.

c. Use insertion elements in ducts not affected by temperature stratification or smaller than one square meter. Use averaging elements where larger or prone to stratification. Sensor length 2.5 m or 5 m as required.

d. Insertion elements for liquids shall be brass separable sockets (thermo-wells) with minimum insertion length of 2-1/2 inches (60 mm).

e. Provide outside air sensors with watertight inlet fittings, shielded from direct rays of the sun. Mount on the North side of the facility.

f. The temperature sensors shall be field verified by the Installing Contractor. Engineer will spot check verify these calibrations during walk through inspection.

g. Wall mounted sensor shall be mounted at 5'-6" above finished floor in an area where they are unobstructed and which free air current is not constricted or blocked, final location shall be approved by the Owner and Engineer prior to installation. Wall sensors in corridors shall have a locking guard. Use digital wall sensors.
Contractor shall submit floor plan showing location of each device with relative equipment, door swing and relevant casework/furniture, etc. information clearly indicated.

h. Sensor elements shall be applicable for the medium being sensed; i.e., room elements, well mounted elements, duct mounted elements and outdoor mounted elements. Range shall be from 0 to 150 °F.

i. Strap on sensors shall not be used unless specifically required.

6. ELECTRONIC STATIC PRESSURE SENSORS
   a. Static pressure sensors shall be differential pressure sensors, with the "high" output sensing the duct pressure and the "low" input sensing atmospheric pressure.
   b. The range for the static pressure sensor shall be matched to the static pressure of the system being sensed, 0 to 0.5-inches, 0 to 2-inches, 0 to 5-inches, or 0 to 10-inches.
   c. Accuracy shall be plus or minus 2 % of the full range being sensed.

7 FILTER STATUS TRANSMITTER
   a. Provide filter status for all central station air handling units. The transmitter shall have both visual monitoring and electronic control of very low differential pressure. The transmitter shall have 4-20ma output signal to be used by the DDC system. Fan coil units shall not have filter status unless the Engineer recommends it.
   b. Transmitter shall be Dwyer series 605.

8. FIRESTATS: Provide UL-listed fire protection thermostats where indicated in main supply and return air ducts of air handling units which are rated less than 2,000 cfm. Connect thermostats which are capable of stopping fans in event of excessive temperatures in fan control circuits. Provide thermostats with fixed or adjustable settings to operate at not less than 75 °F above normal maximum temperature at their location in the air handling system. Comply with requirements of NFPA 90A. Provide thermostats with the following operating features: Provide manual reset type thermostat.

9. TEMPERATURE THERMOSTATS (Stand-alone applications, as required): Two position (On/Off) room thermostat with bimetallic sensing element, set point thumb wheel dial, room temperature indicator, surface mounting base, and hard plastic cover plate, UL listed.

10. HUMIDITY SENSOR/TRANSMITTER: Provide relative humidity sensor/transmitter where shown on the control drawings. Sensor and transmitter shall have a sensor accuracy of ±2 % RH @ 25 °C from 20-90 % RH Output Signal, two wire 4-20 ma linear, proportional to 5-95 % RH Output Signal. The transmitter power shall be compatible with and powered by, the low voltage power supplied by this Contractor.

11. CARBON DIOXIDE GAS SENSOR/TRANSMITTER: A/E shall not use carbon dioxide sensors except where necessary for LEED and/or for Demand Control Ventilation applications or as deemed necessary by the A/E for a specific control requirement. Provide carbon dioxide gas sensor/transmitter where shown on the control drawings. The diffusion gas chamber in the sensor should incorporate a reflective, gold plated light pipe or waveguide surrounded by a gas permeable teflon based hydrophobic diffusion filter that prevents particulate and water contamination of the sensor. The sensor shall provide simultaneous analog outputs in volts and milliamps and shall have a gold bifurcated relay that can be operated as normally open or closed. The sensor shall incorporate elevation correction adjustment and ABCLogic™ (Automatic Background Calibration) software for self-correction of drift to better than ±10ppm per year. The sensor shall have an accuracy of ±75 ppm or 7% of the reading (whichever is greater). All adjustments to the sensor including output scaling, elevation adjustment, relay setpoint, relay dead-band, proportional or exponential output, and single-point calibration shall be made via computer connection to an on-board RJ45 jack. The 8002 product shall also be adjusted using the on-board push
buttons and display. For ease of installation, the sensor shall have a detachable base with all field wiring terminals on the base. Calibration Requirements: Provide with software and two (2) gas canisters (or two (2) gas canisters for every three (3) units installed, whichever is greater), and interface cabling for RS-232. Ancillary Devices Provide mounting bases and/or aspiration box as required per manufacturer's recommendation. This product shall meet or exceed specifications for the Telaire Ventostat® Model 2001V. The CO2 sensor shall be a single beam absorption infrared (non-disperse) type with 18 months parts and labor/5-year calibration guarantee by Telaire International Corp.

12. AIR MONITOR AND CONTROL: Each VAV air handling unit shall have an airflow control station capable of performing constant volume control of outside air without loss of dehumidification at part load. The intent is for the controls to be an integral part of the Building Management and Automatic Temperature Control System.

a. Each airflow monitor and control station shall be complete with velocity pressure transmitter and air volume flow rate control.

b. The major control instruments shall be of industrial process control quality and shall be capable of the following minimum performance:

c. Differential Pressure Transducer: The differential pressure transducer shall be capable of transmitting a linear 4 to 20 ma output signal proportional to the differential (velocity) pressure input signals within the following performance and applications criteria.

d. Calibrated Spans: not greater than 1-1/2 times the maximum design velocity pressure. Calibrated Overall Accuracy: ±1.0 % of span.

e. Repeatability: ±0.05 % of output.

f. Operating Range of Sensor: 20 °F to 150 °F

g. Operating Range of Transmitter: 20 °F to 150 °F

h. The transmitter output shall be unaffected by direction (or attitude) of mounting or external vibrations, and shall be furnished with a factory calibrated span.

I. Units to comply with minimum manufacturers up and downstream configuration to be coordinated with Division 15, Contractor.

13. AIRFLOW MEASURING STATIONS (DUCT AIRFLOW MEASURING DEVICE):

a. Each device shall be designed and built to comply with, and provide results in accordance with accepted practice as defined for system testing in the latest revision of ASHRAE Handbook of Fundamentals as well as the latest revision of the Industrial Ventilation Handbook.

b. Each device shall be designed and built to provide airflow readings across the entire operating airflow range, and capable of operating at 0 – 5000 fpm airflow velocities.

c. The maximum allowable pressure loss through the unit shall not exceed 0.1-inch w.g. Each sensor node shall be calibrated to 16 points of velocity and be capable of measuring the airflow rate within an accuracy of ±2 % of reading, ±0.25 % repeatability. Each Air Flow Measurement System shall be capable of measuring the airflow rate at an installed location which meets Manufacturer's Suggested Placement Guidelines to within + / - 3 % of Reading at any velocity between 0 to 5,000 Feet Per Minute.

d. Stations shall be installed in strict accordance with the manufacturer's published requirements. Modulating control dampers shall be installed downstream of air monitoring stations. Placement of air monitor stations in duct shall be coordinated by the installing Contractor with the manufacturer's local representative prior to installation based on the project actual field conditions. These stations serve as the primary signals for the airflow control systems; therefore it shall be the responsibility of the
Contractor to verify location and installation to assure that accurate primary signals are obtained.

e. The units shall have a self-generated sound rating of less than NC40, and the sound level within the duct shall not be amplified nor shall additional sound be generated.

f. A/E shall specify similar to Ebtron Advantage+ Series Thermal Dispersion Technology or pre-approved substitute. All airflow measuring stations shall comply with the above technical requirements. In the event of noncompliance with the above technical and performance requirements the installing Contractor shall be responsible for providing replacement airflow measurement systems which do meet the requirements.

g. Airflow measuring stations shall be scheduled on the drawings and shown on floor plan/ductwork drawings. Drawing shall show access doors (required for cleaning) and all necessary upstream and downstream clearances.

h. Each air monitor shall be tested by the project test & balance contractor. Tests shall be conducted at each air-handler's minimum and maximum operating fan capacity. If the installed airflow measurement systems readings and project test & balance measurement values deviate more than allowable project specification, adjustments are to be made in conformance with Manufacturers delineated adjustment procedures.

14. WATER FLOW METER

a. For Water Flow Meter requirements, refer to Section 23 05 19 Meters and Gages for HVAC Piping.

15. BTU METERING

a. For BTU Meter requirements, refer to Section 23 05 19 Meters and Gages for HVAC Piping.

16. REFRIGERATION LEAK DETECTORS:

a. Provide refrigerant leak detectors with up to 4 remote sensor inputs, controller furnished complete with alarm relays and control relays for Start - Stop control of area makeup and exhaust fans. Sensors will be solid state to include Ammonia and Freon. R-22, R-123 and 134 shall be provided to match selected chiller. Sensors can be located up to 500 feet from the control unit. Control unit to include visual alarms with discreet LED's for which sensor has caused the alarm. System will have a built in time delay to prevent false alarms. Provide panel with test buttons for audible and visual alarms.


17. LOW TEMPERATURE LIMIT SENSORS: Provide low temperature protection thermostats of manual-reset type, with sensing elements 8-feet or 20-feet in length. Provide thermostat designed to operate in response to coldest 1-foot length of sensing element, regardless of temperature at other parts of element. Support element properly to cover entire duct width. Provide separate thermostats for each 25 square feet of coil face area or fraction thereof.

18. CONTROL WIRING: All conductors shall be of stranded copper wire.

a. All PVC/EMT/rigid steel conduit and outlet boxes shall conform to the requirements specified under Division 16, Electrical.

b. All cable runs exposed in return air plenums shall be smoke rated for the application and secured to the building structure. Do not run wire in drywall without conduit.

c. All wiring cables shall have 600 volt insulation.

d. Cables shall be properly identified/tagged with matching wire markers on both ends as to the control point.
e. All cables from ceilings to wall temperature sensors shall be installed in conduit (EMT). EMT Conduit fittings shall be steel compression type. Set Screw fittings are not acceptable.

f. Non conduit wires (exposed wires above ceiling) will be decided by the detail spec (project scope).

PART 3 -- EXECUTION (Not Used)

END OF SECTION 23 09 00
PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENTS

A. Design piping systems in accordance with the requirements set forth and no less than the minimum per the latest Florida Mechanical Code requirements.

B. Pipe wall thickness. Wall thickness shall be calculated as per ASME B31.3.

C. A material allowance shall be added to the above calculated wall thickness to account for progressive deterioration due to the effect of corrosion, erosion, wear, and material removed for threading or grooving.

D. Design temperatures shall be 45 °F for chilled water, 160 °F for hot water, and 95 °F for condenser water. Design pressures for distribution shall be 200 psi.

E. Condenser water design pressures shall be determined by the A/E.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Above ground PIPES & PIPE FITTINGS

1. General: No PVC pipe shall be used.

2. Steel Pipe: Steel pipe shall be ASTM A53 Seamless pipe (Type-S) Grade B. If other standard needs to be specified, Engineer shall discuss with Owner.

3. Steel fittings shall be ASTM A234 wp 91 tempered.

4. Flanges

5. Condensate Drain Piping -Type L copper tubing with 95-5 sweated fittings.

B. UNDERGROUND PRE-INSULATED PIPES

1. Underground pipes shall be factory pre-insulated steel piping.

2. The carrier pipe shall be steel ASTM A-53, Grade B, seamless (Type S), standard weight for sizes two (2) inches and larger, and shall be ASTM A-120/A-53, Grade F (Type F), standard weight for sizes 1 to 1 1/2-inches and smaller. Seamless pipe smaller than two (2) inches shall be ASTM A-106, or A53, Grade B. Condensate return piping shall be schedule 80. When practical, piping shall be provided in forty (40) foot double-random lengths. All carbon steel pipe shall have ends cut square and beveled for butt welding. Straight sections of factory insulated pipe shall be six (6) inches of exposed pipe at each end for field joint fabrication.

3. Polyurethane foam insulation shall be injected with one shot into the annular space between carrier pipe and jacket with a minimum insulation thickness of three (3) inches. Insulation shall be rigid, 90-95 % closed cell polyurethane with a 2.0-to-3.0 pounds per cubic foot density and coefficient of thermal conductivity K-Factor) of 0.14 and shall conform to ASTM C-591. Maximum operating temperatures shall not exceed 250 °F. Insulation thickness shall be specified by calling out appropriate carrier pipe and jacket size combinations.

4. Jacketing material shall be high density polyethylene (HDPE), conforming to ASTM D-1248. Wall thickness for HDPE jacketing shall vary according to pipe size. Piping wrap shall be heat shrunk at closures. Jacketing for above ground, outdoors installations shall contain ultraviolet inhibitors for protection for sunlight. No FRP jacket allowed.
PART 3 – EXECUTION

3.1 EXECUTION

A. All piping, fittings, specialties, etc. are to be installed in strict accordance with manufacturer's instructions and sound engineering and Code practices.

B. Pipe two (2) inches and smaller shall be threaded or socket welded.

C. Pipe greater than two (2) inches shall be three-pass butt welded. Root pass shall be inspected before other passes are made.

D. Piping installation is to be level. Pipe is to be concealed in chases except in unfinished rooms and when installed above ceiling. No PVC pipe is to be used. Flexible connections are to be installed at all vibrating equipment. Pipe branches from mains must incorporate one change of direction in horizontal plane and one in vertical plane before connecting to equipment. Change of direction are not required if main piping is anchored at branch take-off. Drain valves are to be installed at low points in piping to permit draining of system. Di-electric unions are to be provided between dissimilar metals. Each piece of equipment is to be provided with shut off isolation valves. Air vents are to be installed at all high points, piping drops, and other points where necessary for air removal. A back flow preventer and shut off is to be provided at water service connection.

E. Balancing valves and orifices are to be provided sufficient lengths of straight pipe upstream and downstream of valves, fittings, etc. to reduce turbulence to a minimum.

F. Condensate piping is to be pitched a minimum of 1/8 inch per foot and provided with clean-outs at every 90 bend and at convenient intervals in straight lines. A trap is to be provided at each equipment connection to drain. Water seal must exceed maximum pressure developed by equipment.

G. Buried piping is to be at a minimum of forty-eight (48) inches for Tampa campus, and thirty-six (36) inches for Sarasota and St. Petersburg campuses. Joints and fittings are to be carefully excavated and buried so that the piping load is not supported by the joint, etc.

H. Sleeves are to provide at least one (1) inch clearance all around pipe and insulation and are to be sealed in exposed areas, through fire walls with fire proofed sealant, and partitions. Insulation must be continuous through sleeves. Where pipes pass through floors top of sleeve is to be set two (2) inches above finished floor and flush with underside of floor. Unused sleeves are to be plugged.

I. Hydronic Testing – Piping System are to be purged of all air and hydrostatically tested at 1.5 times the maximum system design pressure, but not less than 100 psig for a minimum of fifteen (15) minutes. No pressure drop is to be allowed. The A/E and Owner’s representative are to witness the tests. Any leaks are to be repaired by replacing defective fitting, joint or piece. Defective section is to be re-tested after repair and witnessed by the Project Architect/Engineer and the Owner’s representative. Back filling, concealing, and insulating is to be done after successful hydrostatic test and after Inspector approval.

J. Adjusting and Cleaning - Clean and flush hydronic piping system.

K. Piping Supports - All piping supported from the ceiling shall have at least one foot long saddles of sufficient strength to ensure pipe hangers do not cut into the insulation.

END OF SECTION 23 11 00
PART 1 – GENERAL

1.1 GENERAL PROVISIONS

A. DRAWINGS

1. Contract drawings shall identify the portion of each duct system to be constructed for a particular pressure class.

2. Contract drawings shall identify and designate the duct pressure class for each system. All ducts shall be constructed in accordance with SMACNA and meet or exceed the specific duct pressure class for each system. All ducts shall be sealed to Seal Class A for duct closure. A/E shall specify the sealant to be used.

3. Contract drawings shall indicate all service openings as required by NFPA. Special attention should be given to access coils for cleaning.

4. Contract drawings shall indicate all openings for thermometers and controllers.

5. Contract drawings shall indicate all dampers, all necessary details, hanger/supports details, and spacing.

6. Drawings shall be double line.

7. In renovation work, contract drawings shall directly state that abandoned and/or replaced ductwork located in the HVAC scope of the project shall be removed from the building. Ambiguous areas shall be discussed with the USF Project Manager.

B. SHOP DRAWINGS

1. A/E shall specify shop drawings to be submitted for A/E approval before fabricating ductwork. (Two (2) approved copies shall be sent to owner.)

2. Shop drawings shall include as a minimum:
   3. Mark of each duct section
   4. Pressure class of the duct section
   5. Gauge of material
   6. Duct reinforcement (if any)
   7. Transverse joint reinforcement
   8. Longitudinal seam
   9. Intermediate reinforcement (if any)

1.2 DESIGN CRITERIA

A. A/E shall select the duct sizing method and report same to the owner. Special attention should be given to noise control when selecting sizing method and materials.

B. Return air system shall be ducted directly back to the air handling unit.

C. Internal duct liner SHALL NOT be specified, unless discussed with Owner.

D. Fibrous duct SHALL NOT be specified.
E. Generally duct material shall be galvanized (G90) steel. A/E shall analyze each environment and make recommendations on 1.) the galvanized coating designation or 2.) the selection of alternative duct materials e.g. fiberglass, PVC, Stainless steel etc.

F. Maximum developed length of flexible duct shall be 6-feet.

G. Specify double wall turning vanes for ducts supply and return.

**PART 2 – PRODUCTS**

**2.1 MATERIALS**

A. Sheet metal shall be per ASTM A-525 or A-527 regular spangled, non-oiled with a minimum zinc coating designation of G90. A/E shall make recommendations.

B. Threaded rod hangers, when used, shall be galvanized with double nuts and lock washers.

C. Take-off fitting with damper: Shall be commercial quality with continuous weld seams, heavy duty damper & handle with standoff to allow blanket type insulation, conical similar to FlexMaster USA model STOD-B03 with full width damper rod with nylon bushings or equal bellmouth or rectangular to round take-offs.

D. Outside Air Dampers: Shall be AMCA Certified Ultra-Low leakage Class 1A airfoil control damper. Damper blades shall be high yield aluminum airfoil construction with stainless steel linkages, corrosion resistant axles, jamb seals molded synthetic bearings, low pressure drop similar to Ruskin CD50 or equal.

**PART 3 – EXECUTION**

**3.1 EXECUTION**

A. Generally ducts shall be installed four (4) inches below the building structure above.

B. Leakage testing must be specified, per SMACNA criteria. The A/E should specify that the testing is witnessed by the Engineer, TBA agency, and the owner representative.

C. All ducts openings shall be protected with vesquine during construction. If ducts were not protected, then the Contractor shall vacuum before starting of air handler fans, at no cost to the Owner.

D. Welding shall be as per specification for welding sheet metal (AWS 1990).

E. Ducts shall have access doors every fifty (50) feet.

**END OF SECTION 23 31 13**
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 34 23 HVAC POWER VENTILATORS

PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENT

A. Fans shall be direct drives with speed controllers. If fan duty cannot be achieved, the A/E shall discuss potential options with USF before selection is made.

B. Fan noise levels shall be selected to achieve the NC levels in all occupied spaces (at lower end of the range) as per the latest edition of ASHRAE HVAC Application Handbook.

C. Fan operation shall be verified (thru EMS) by flow switch for belt drives and flow switch/current sensor for direct drive.

D. Don’t use axial flow fans unless written permission is granted

PART 2 – PRODUCTS

2.1 MATERIALS

A. Engineer shall analyze the environments (both inside and outside), select materials to ensure long life with minimum maintenance, and discuss the selections before schematic submittals.

PART 3 – EXECUTION

3.1 EXECUTION

A. Provide fixed sheaves after final balance.

END OF SECTION 23 34 23
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 37 13 DIFFUSERS, REGISTERS AND GRILLS

PART 1 – GENERAL

1.1 DESIGN CRITERIA

A. A/E shall select and schedule air devices for the specific application on a room by room basis to achieve the mixing ventilation and distributed airflow necessary for desired comfort of the space.

1. Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Air devices shall be selected based on best industry practices necessary to achieve quite operation throughout the operating range of the device. Refer to the specific noise criteria limits for the given application/space.

C. Submit engineering data in a manner to facilitate convenient review of aspiration ability, including temperature and velocity traverses, throw and drop, noise criteria ratings sizes, free area and quality of construction. Outlets shall be selected for maximum noise criteria level as scheduled on drawings.

D. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 2 – PRODUCTS

2.1 MATERIALS

A. Indoor air devices shall be constructed of Aluminum unless the application dictates otherwise (i.e.; highly corrosive environments).

B. Finish shall be powder coat or baked enamel, white unless otherwise required for the application.

PART 3 – EXECUTION

3.1 EXECUTION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

D. Provide accessible balancing dampers in duct branches and/or devices were necessary to allow for proper balancing. Dampers shall be selected and installed so as not to induce air noise above the noise criteria of the room.

E. Paint ductwork visible behind air outlets and inlets matte black.
F. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 23 37 13
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 41 00 PARTICULATE AIR FILTERATION

PART 1 – GENERAL

1.1 DESIGN CRITERIA

A. Drawing shall indicate filter removal/replacement space which shall be dimensioned. Air handler schedule shall include filter size.

B. Filter efficiencies shall be selected based on the areas served. Engineer shall address special filtration needs at advanced schematic.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Provide two (2) inch thick pre-filters, with MERV 8 minimum efficiency. Pre-filters shall be Pleated type.

B. Provide four (4) inch thick final-filters, with MERV 13 minimum efficiency. Final Filters shall be Cartridge type. No roll filters.

PART 3 – EXECUTION

3.1 EXECUTION

A. During construction filter pressure drop shall be monitored. Filters shall be replaced when pressure drop reads the manufacturers recommended loaded filter pressure drop (approximately one (1) inch of water column).

B. New filters shall be installed at substantial completion.

C. Three (3) spare sets of main filters shall be supplied to USF at substantial completion.

END OF SECTION 23 41 00
DIVISION 23 — HEATING, VENTILATING, AND AIR CONDITIONING (HVAC)

SECTION 23 73 13 MODULAR INDOOR CENTRAL STATION AIR HANDLING UNITS

PART 1 – GENERAL

1.1 PERFORMANCE REQUIREMENT

A. Engineer shall discuss type of AHU (draw through, blow through, etc.) with USF before selection is made. Energy efficiency shall be of paramount concern. Typical design shall be VAV system with no simultaneous heating and cooling.

B. Roof mounted air-handlers are not allowed unless an exception is requested and approved by FP&C and PPD.

C. Don’t use axial flow fans unless written permission is granted.

D. Access doors shall be provided for service of all components.

E. For special applications, Engineer shall discuss recommendations with USF at Advanced Schematic.

F. Air-handler cooling coils selections shall be based on a nominal leaving air temperature of 52 °F and 15 °F water temperature rise. Hot water coils shall be based on a 50 °F water temperature drop. (Note: This difference shall be measured at the mains. (Engineer shall show calculations for mixed flow to verify the temperature in the pipe mains.)

G. Three-way mixing or bypass valves are not acceptable. Use only two-way valves with Grizwold type pressure independent flow control valves (PICCV). Refer to Section 23 09 00 Instrumentation And Control For HVAC, 2. Automatic Control Valves and Operators for additional requirements.

H. Each AHU shall have temperature and pressure valves on the supply and return chilled and hot water lines.

I. All 100 % outside air units shall be equipped with preheat coils.

J. The A/E shall specify Heat Pipe air-to-air energy recovery equipment Heat Exchangers. Heat Pipes shall be installed at the air-handler factory.

K. The A/E shall specify factory installed encapsulated UV-C lamps for surface treatment of cooling coils in excess of 6 rows. Lamps shall be designed and installed in accordance with the latest version of the ASHRAE Handbook - HVAC Applications – HVAC System Surface Treatment. UV-C lamps shall be installed at the air-handler factory. Provide UV-C lamps on all units equipped with Heat Pipes.

L. Fan walls shall be given consideration for use on air-handlers. Review job specific details and options with the USF Project Manager and Mechanical Engineer at the Schematic Phase level before finalizing air-handler selections.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Air handling unit shall be insulated double walled with no exposed insulation in the air stream.

B. Drain pan shall be stainless steel.

C. The preferred maximum number of hydronic cooling coil row/fins per inch (fpi) is 6/14. If coil duty requires greater row/fpi then unit shall be equipped with UV-C lamps and adequate clearances for cleaning and maintenance. Also consider split coils with access clearance between coils for cleaning.

D. Coils shall have a stainless steel frame.
E. Fans shall be direct drives with speed controllers. If fan duty cannot be achieved, the A/E shall discuss potential options with USF before selection is made.
   1. Fan noise levels shall be selected to achieve the NC levels in all occupied spaces (at lower end of the range) as per the latest edition of ASHRAE HVAC Application Handbook.
   2. Fan operation shall be verified (thru EMS) by flow switch for belt drives and flow switch/current sensor for direct drive.

F. Provide Variable Frequency Drives (VFD) for all air-handler (variable air volume and constant volume) applications. Other control methods shall be approved, in writing, by USF. Each VFD to be provided with lightning surge protection and manual bypass.

G. The VFD shall be compatible to the Energy Management System. The VFD shall accept 4-20 ma or 0-10 Volt signal to control the frequency on the drive. Furthermore, the VFD shall communicate to the EMS through BACNET protocol. Approved manufacturers are:
   1. ABB, Danfoss-Graham, Yaskawa, and Square D.
   2. Regional campus facilities may specify alternate manufacturers.

**PART 3 – EXECUTION**

3.1 EXECUTION

A. Air handlers shall be installed to limit noise and vibration. Refer to Section 15245. Air-handlers scheduled to be floor mounted shall be installed on nominal 6” high concrete housekeeping pads. Additionally, provide double deflection neoprene pads between the concrete pad and air handler units for isolation of the dissimilar materials.

B. With unit running, water flow test shall be done to ensure adequate condensate drainage.

C. A limit water switch shall be installed on drain pan. Limit switch shall disable AHU.

D. Provide ball valve and piping on air handler coil air vents.

E. Air cleaning and filtration efficiencies for each air handling system. These shall be clearly shown on design drawings. Refer to Section 23 41 00 Particulate Air Filtration for additional requirements.

END OF SECTION 23 73 13