DIVISION 23 - HVAC

Contents

23 05 00 Common Work Results for Heating, Ventilating, and Air Conditioning

Design Standards

1. Specify that all condensate drains discharge directly to sanitary sewer or to the exterior of the building. At no time shall any drain be allowed to discharge onto finished floor.

2. Do not specify any piping beneath the building slab. Utilities shall enter the building through a utility trench or areaway.

3. The steam piping system shall meet the most recent versions of ASME and ANSI B31 Pressure Piping Code and include a steam flow metering system with connectivity to Johnson Controls Metasys.

4. Chilled water system drawings shall show primary and secondary diagrams.

5. Specify that the building primary chilled water loop have a crossover bridge with a check valve to allow for building flow to prevent campus chilled water loop short-cycling.

6. The HVAC system shall also be designed for compatibility with and connection to building automation and energy management systems.

7. The designer shall require submittal and product data on all equipment and products necessary to ensure compliance with the contract documents and for inclusion in required maintenance manuals.

8. The designer shall include adequate climate control for all equipment rooms associated with elevators and account for the thermal load of all machinery, electrical and electronic devices installed.

9. Do not specify variable refrigerant flow systems for habitable spaces. VRF systems can only be used in the form of mini-split type units where each evaporator and fan are served by a single condenser and compressor to control additional heat loads in mechanical, electrical, telecommunications, and equipment areas.

10. Specify that the contractor shall obtain and pay for all installation permits, certificates, and inspection fees relative to the work. The preparation of any specific plans or shop drawings necessary to obtain these permits shall also be the responsibility of the contractor.

11. Specify testing, adjusting, and balancing of any appropriate mechanical system by an independent testing firm that is compliant with Section 23 05 93. The balance report shall be required and shall contain data considered necessary to properly document the results of this balancing. These reports shall be included in the closeout documents.

12. Installers shall provide as-built locations of all remote-control devices such as differential pressure transmitters, duct static pressure transmitters, duct smoke

detectors, etc. on control drawings and record drawings.

Equipment Sole-Source Suppliers

Clemson University has Johnson Controls, Inc. under contract to provide installation of building automation systems and components. The contractor must review and submit to Clemson the pricing received in accordance with the terms and conditions of that contract. Specific details of each contract must be provided in the specifications; name, contact information, solicitation number, and expiration date. Documentation of the evaluation of this pricing information must be kept for review by Audit and Certification.

23 05 19 Meters and Gauges for HVAC Piping

1. Pressure gauges shall have maximum readings approximately two times the expected working pressure. A gauge cock shall be specified between each gauge and the main line.

2. Specify that steam meters and chilled water meters provide connectivity to campus Johnson Controls Metasys.

23 05 23 Valves

1. Specify that valves be installed with stems horizontal or above. Arrange valve handles to be easily accessible.

2. All valves shall be identified with metal tags.

3. Specify that valves be installed at all locations requiring shut off during maintenance, component isolation and troubleshooting.

4. All low pressure (below 40 psi) valves for steam piping within buildings shall be a bronze rising gate valve conforming to MSS-SP80, and ANSI Class 125 pressure and temperature ratings at a minimum.

5. All medium and high pressure (above 40 psi) valves for steam piping within buildings shall be a stainless-steel gate valve with ANSI Class 4 leakage, and ANSI Class 800 pressure and temperature ratings at a minimum.

23 05 29 Hangers and Supports for HVAC Piping and Equipment

1. Specify that all hangars and supports shall be engineered to carry the anticipated loading.

2. Specify that hangers supporting insulated piping be sized to fit over the insulation.

3. Specify that supports and clamps in contact with copper pipe shall be copper plated.

23 05 53 Identification for HVAC Piping and Equipment

1. Specify that all piping is to be marked and coded with color coded tape in accordance with Section 33 05 97, in a neat and uniform manner. Markings shall not exceed 20

feet apart in mechanical rooms. The wording and color coding shall be coordinated with other plumbing, electrical, and other trades and suppliers.

2. The wording on identification markers shall be descriptive of the item identified, i.e., "H.W. Return", not "Pump 28."

23 05 93 Testing, Adjusting, and Balancing for HVAC

1. Specify any necessary tests that are to be conducted by a certified testing adjusting and balancing (TAB) contractor on any equipment or systems as appropriate for each specialty of the mechanical system.

2. Specify that all tests are to be made in the presence of the mechanical contractor or Clemson Universsity, and that accurate records be kept of test readings and that the test results shall be incorporated in the maintenance manuals.

3. Specify that the TAB contractor is to furnish all labor and technical personnel, instruments, and appliances for these tests. If the gauges, thermometers, etc., that are used for these tests are to be left permanently installed, then they are not to be installed until just prior to the tests so that possible changes in calibration can be avoided.

4. Specify any action necessary to protect components of the systems being tested from damage during these tests.

5. Clemson University retains the right to contract directly with a TAB contractor to perform all tests and adjustments to the mechanical systems in accordance with the design.

6. Specify that the HVAC contractor shall coordinate and cooperate with the TAB contractor to ensure that the testing and balancing work can be accomplished in an appropriate and timely manner.

7. The designer shall coordinate their design with the TAB contractor in order that the installation of effected equipment (fittings, connecting devices, etc.) will ensure an efficient method of accomplishing the testing and balancing.

8. Upon completion of testing and balancing, all transfer grills shall be open and functioning, and all steam and chilled water supply and return valves shall be open and flowing.

23 07 00 HVAC Insulation

23 07 13 HVAC Duct Insulation

1. Specify that exterior insulated ductwork have insulation protection made of metal or a resilient, self-healing material.
2. Insulation shall not be pulled overly tight around ducts when wrapping.

3. Use 8" minimum length board type insulation on bottoms of ducts at trapeze hangers.

4. No duct liner is permitted. Specify that insulation shall be installed on exterior of duct only.

5. Specify that outside air intake ducts shall be insulated.

6. Return ducts and exhaust ducts shall not be insulated unless passing through unconditioned space.

23 07 19 HVAC Piping Insulation

1. Specify that pipe insulation shall be installed with staggered longitudinal joints.

2. Specify the use of vapor barriers for insulated pipes that may be subject to condensation on its exterior or on piping located in damp areas.

3. Specify that exterior insulated piping have insulation protection made of metal or a resilient, self-healing material.

4. Specify that insulation on steam and condensate lines should be of a thickness to reduce surface temperature to 110 degrees Fahrenheit except in buildings where it is necessary meet requirements for insulation value from the International Energy Conservation Code as adopted Chapter 5 of OSE Manual.

5. Steam, condensate, and vent piping shall have insulation applied with side and end joints butted tightly.

6. Pipes fittings and valves on hot water lines shall be insulated in accordance with the requirements in the International Energy Conservation Code as adopted by Chapter 5 of OSE Manual or to the level of the any existing system being connected to, whichever is greater.

7. Pipes fittings and valves on cold water and chilled water lines shall be insulated with fabricated or mitered sections of pipe insulation or pre-molded sections and vapor sealed.

8. Pipe fittings and valves on steam, condensate, and vent lines shall be insulated with fabricated, mitered segments of pipe insulation. At screen strainers and other fittings requiring routine access for maintenance, fabricate the insulation so that it can be removed and replaced as necessary.

9. Specify that each pipe support on piping 2” and larger shall be provided with equal thickness 12” long sections of Foamglass with jacket carried continuously over the Foamglass and vapor sealed as appropriate.

23 09 00 Instrumentation and Control for HVAC

1. The design of the HVAC system shall provide for a complete system of automatic temperature control of the direct digital type as manufactured by Johnson Control Company. No other control manufacturer will be allowed.

2. The system controls shall provide a distributed process network control system

complete with all necessary hardware and software, including all required programming. The system shall be PC microprocessor based and monitored by connection to the existing building automation system to allow for alerts for leaks.

3. The Owner will provide a fiber optic data transmission cable to the specified site location to transmit data to the University Energy Management System.

4. Specify that thermostats shall be wall mounted within acceptable reach ranges in accordance with the current version of ICC A117.1. Thermostats shall have the capability of range limits and "dead band" control in accordance with policies set forth by Facilities Energy Awareness.

5. All secondary overflow pans for AHU's described in Section 23 73 00 and fan coils described in Section 23 82 00 shall have a float switch that is interlocked with chilled water cutoffs that activates when pan is filling with excess water.

6. Update building automation systems, including user views, to reflect changes to and the addition or deletion of any connected system component.

7. All building automation systems shall be designed and installed in accordance with the Clemson Building Automation Standards.

23 09 13 Instrumentation and Control Devices for HVAC

1. Clemson University has Johnson Controls Inc. under contract to provide installation of approved Building Automation Systems and components. The contractor must review and submit to Clemson for evaluation of the pricing received in accordance with the terms and conditions of that contract. These specific details of each contract must be provided in the specifications; name, contact information, solicitation number, and expiration date. Documentation of the evaluation of this pricing information must be kept in each procurement file for review by Audit and Certification.

23 11 00 Facility Fuel Piping

23 11 23 Natural Gas Piping

1. All rigid Natural gas piping shall be schedule 40 black iron.

2. All fittings for rigid gas piping shall conform to the following:

   - Fittings for pipe 2 ½" or smaller shall have threaded connections
   - Fittings for pipe larger than 2 ½" shall have flanged or welded connections
   - All black iron gas fittings shall be malleable black iron.

3. All flexible gas piping shall allow for proper grounding and bonding.

4. Approved connections between piping of dissimilar metals shall be dielectric fittings such as a union, nipple or flange.

23 11 26 LP Gas Piping

1. Follow Section 23 11 00 above.

23 20 00 HVAC Piping and Pumps

23 21 00 Hydronic Piping and Pumps

1. Specify that all piping be neatly arranged, running parallel with the primary lines of the building construction, and that right-of-way be given to piping that must slope for drainage.

2. Specify that unions or flanges are to be provided at all connections to each piece of equipment and on both sides of automatic valves and devices that require removal for maintenance.

3. Approved connections between piping of dissimilar metals shall be dielectric fittings such as a union, nipple or flange.

4. Specify that bronze adaptors are to be used at all copper to flanged or I.P.S. connections.
5. In locations where piping passes through or under corrosive fill or walls, specify that the piping shall be protected through the full depth of the construction by protective coating, wrapping, or with galvanized sleeves. Sleeves shall be at least two pipe sizes larger than the pipe plus insulation.

6. Specify that all bare steel piping, pipe hangers, supports and miscellaneous metal mechanical rooms and elsewhere exposed to view shall be cleaned and painted in accordance with requirements specified in Division 09.

7. Specify that all condensate drains discharge directly to sanitary sewer or to the exterior of the building. At no time shall any drain be allowed to discharge onto finished floor, walking path, sidewalk or accessible route.

8. All pumps shall have isolation valves installed to allow servicing the pump.

9. All pumps shall be controlled by differential pressure sensors. No sensorless pumps shall be installed.

10. Horizontal steam and hot water piped are tapped for feeder lines, the tap shall be placed on the top or side of pipe.

11. All steam condensate lines shall be Schedule 80 piping.

23 21 16 Hydronic Piping Specialties

1. Include a Chilled water bridge installed per Clemson's Chilled Water Bridge Detail in all new building construction and renovations affecting building Chilled Water Connections.

23 30 00 HVAC Air Distribution

23 38 13 Commercial Kitchen Hoods

1. All interconnected kitchen exhaust hoods, control systems, and exhaust fans shall be provided by the same manufacturer to ensure full compatibility

23 38 16 Fume Hoods

1. Laboratories that are designed to be equipped with ventilation fume hoods shall be well planned with the necessary duct work system to support the hood operation.

2. Clemson University Department of Occupational and Environmental Safety has operation and maintenance guidelines as well as design information for fume hoods that must be followed.

23 40 00 HVAC Air Cleaning Devices

23 41 00 Particulate Air Filtration

1. Filtration design shall be based on the latest edition of ASHRAE 52.2 to provide MERV 13 or better filtration according to the application. Higher standards may be necessary for some laboratory applications and clean room designs.

2. All MERV 13 and HEPA filter banks shall have an appropriately selected prefilter as a means of extending their service life.

23 64 00 Packaged Water Chillers

1. Centrifugal chillers with single stage compressors are preferred at Clemson University.

2. Refrigerants shall not be blended and shall be selected based on current availability, but the chiller shall be capable of being easily converted to accommodate the use of less ozone depleting refrigerants, without having to be derated, as they become commercially available.

23 73 00 Indoor Central Station Air Handling Units

1. Air handling units shall be appropriately sized and selected to fit the application with the appropriate modules for the required functions.

2. All air handling units within a project or new facility shall be specified to be supplied by a single manufacturer.

3. Specify that all air handers shall have a stainless-steel drain pan that is constructed

either of a single sheet or with welded joints. This pan shall also be at least 4” deep and maintain between 6”-12” of horizontal clearance from the air handler.

4. Concrete pads for AHU’s shall be epoxy coated. Coatings shall be applied in place with straight, feathered edges. Prepare new and existing surfaces to be coated by shotblast etching existing glossy surfaces per manufacturer’s instructions.

23 81 00 Decentralized Unitary HVAC Equipment

23 81 26 Split-System-Air-Conditioners

1. Provide hail guards for condensers.

2. Repair or replace coils per manufacturer’s instructions if the unit sustains damage.

23 82 00 Convection Heating and Cooling Units

23 82 19 Fan Coil Units

Specify each unit shall have the following:

1. Cabinets are to have extended pocket, 18-gauge galvanized construction, closed cell insulation with insulated stainless steel or heavy composite drain pan. Coordinate finish color with Project Manager.

2. Fan coil units for service spaces such as penthouses, mechanical rooms, IT closets, etc. are to be vertically oriented instead of the customary horizontal units used in occupied spaces.

3. 1” pleated filter sets. Install new filters at Substantial Completion.

4. A factory installed service disconnect switch.

5. All overhead fan coils concealed above ceiling shall have a stainless-steel secondary drain pan that is constructed either of a single sheet or with welded joints. This pan shall also be at least 4” deep and maintain between 6”-12” of horizontal clearance from the fan coil.

6. All chilled water piping components shall be located above secondary drain pan.

7. A condensate overflow switch shall be installed per Section 23 09 00.

8. Units are to be configured for chilled water and hot water connections on either side.

9. Fan motors shall have three speeds. All cooling and heating performance data must be based on high-speed fan operation.

10. Chilled Water Entering Water Temperature shall be 48 degrees.

11. Hot Water Entering Water Temperature shall be 140-160 degrees.

12. A Preheat Coil shall be installed, and Low Limit protection shall be provided if the unit has Outside Air connected to the unit.

13. Coils shall be furnished with manual air vents. Chilled Water and Heating Coils shall be downstream of Preheat Coil. Heating Coil shall be located downstream of Chilled Water Coil.

14. All piping and piping components inside Fan Coil shall be factory supplied or factory installed. If piping package is supplied for field install, the union connection shall be factory installed. Piping packages will consist of:

    - Supply side to have shut off valve, strainer with hose drain fitting and cap, union connections.

    - Return side to have proportional control valve, automatic flow limiting balance valve, shut off valve and union connections.

15. All control valve actuators shall be proportional control 0-10VDC. All control valves shall be 2-way configuration. All control analog inputs and outputs shall have the ability to be field calibrated.

16. Unit microprocessor shall be factory supplied or factory installed and must have BACnet communication capability. All set points shall be adjustable via BACnet communication.

17. Provide adequate owner training for unit controls and operation startup with commissioning. All software and hardware for the field accessibility of the unit controls is required.

18. All units shall have the following points configured:

    - Discharge Air Temp, Room Temperature, Occupied Mode, Occupied Cooling SPT, Occupied Heating SPT, Standby Cooling SPT, Standby Heating SPT, Unoccupied Cooling SPT, Unoccupied Heating SPT, Supply Fan Start/Stop, Supply Fan Status, Condensate Overflow Switch Status.

    - <u>If Dehumidification is Required</u>: Room Humidity, Dehumidification SPT IF ECM MOTOR IS INSTALLED Supply Fan Speed Control

    - <u>If Unit has Outdoor Air Connected</u>: Outside Air Damper Position, Low Limit Status, Room CO2

    - Condensate pan overflow sensors shall shut off chilled water to unit.

PRODUCTS AND MATERIALS – DIVISION 23 – HEATING, VENTILATION, AND AIR CONDITIONING

Access Doors (Equipment)

- Titus
- Krueger
- Cesco
- Dowco
- Air Balance
- Kees
- Louvers & Dampers
- Ruskin

Air Control Tank Fittings

- Bell & Gossett or approved equal

Air Filtration Media

Comply with standards listed in Section 23 40 00.

Air Handling Units

- Trane
- York
- VTS
- Carrier
- Daiken

Do not mix brands in the same installation

Chillers

Must comply with Section 23 64 00.

- Trane
- Carrier
- York

Dampers

- Manual Volume Control Dampers**:** Ruskin, Dowco, Louvers & Dampers, Air Balance, Arrow
- Fire Dampers**:** Air Balance, Louvers & Dampers, Prefco

Exhaust Fans

- Carnes
- Jenn-Aire
- I.L.G.
- Penn
- Acme
- Greenheck
- Broan
- Cook

Epoxy Coatings

- Sherwin Williams Resoflor Topfloor Mer 1 or approved equal
  - Color: Owner Selected High Gloss

Fan Coil Units

- Trane
- Johnson Controls
- Rittling

Flexible Ducts

- Wiremold
- United States Metal
- Clevepack
- Metal Flex

Flow Switches

- Fluid: McDonnell-Miller FS-4, Johnson Controls, Penn
- Air: Penn or approved equal

Gas Piping

- Rigid Piping: Black Iron, Schedule 40 meeting most current version of ASTM A53f or A120
- Fittings: Malleable Black Iron
- Flexible Piping: FlashShield+ or approved equal

Hangers and Support Devices

- Grinnell
- Unistrut
- Fee & Mason
- Elcene Kindorf
- Mueller
- Auto Grip

Hose Bibbs

Tamper-proof as needed with anti-siphoning vacuum breaker from the following manufacturers

- Zurn
- Watts
- Woodford

Insulation

- Chilled and Hot Water Piping**:** Armaflex or 1-1/2" Fiberglass minimum with 850 degree F rating with self-sealing all-purpose jacket, 25/50 spread/smoke development rating. Insulation on fittings and valves shall match that installed on piping or approved equal.

- Low Pressure Steam and Condensate Piping: Pyrogel XTE or approved equal: Use in steam vaults and areas with limited accessibility/working clearances.

  John-Mansfield Thermo-12 Gold or approved equal: Use in all locations except those with limited accessibility/working clearances.
- Hot Water Storage Tanks and Generators**:** 3" blocks of 85% magnesia, securely wired into place, covered with 1-1/2" mesh wire with layer of plastic insulating cement 3/8" troweled over the wire, then finished with a 1/8" layer of hard finish cement, troweled to smooth hard finish.
- Converters**:** Same as hot water storage tanks, except use ½" magnesia and add one coat of vapor barrier sealant
- Refrigerant Piping**:** 1" Armaflex or approved equal
- Supply Ducts (Exposed Areas):
  - 1-1/2" glass fiber blanket, ¾ lb. density with .002 aluminum foil backing as manufactured by Owens-Corning, Certainteed, Johns-Manville, Armstrong, or BFG.
  - 1-1/2" fiberglass, 3.0 lbs/cf density, with foil reinforced Kraft jacket (O-C Type 703) or approved equal
- PVC Fitting Covers**:** Certainteed or approved equal

Mastics, Coatings, and Adhesives

- Mastics**:** Insul-Coustic, Lion Oil, Foster, Armstrong, Childers white breaker coating, or Foster 30-36
- Breather Mastic**:** Foster GPM or approved equal
- White Vapor Barrier Coating**:** Foster 30-35 or approved equal
- Duct Insulation Adhesive**:** Foster 85-20 or approved equal
- Lap Adhesive**:** Foster 85-75 or approved equal
- Flexible Joint Sealer**:** Foster 30-35 or approved equal

Mini-Split/VRF Systems for Service Spaces

- Trane
- JCI/York
- Daikin
- Mitsubishi

Packaged AC Equipment

- Trane
- Carrier
- Lennox
- York

Pre-Filter Chemical Feeder

- Neptune or approved equal

Pressure Gauges

- Ashcroft or approved equal
- Dwyer or approved equal

Pumps

- Taco
- Bell & Gossett
- Patterson Pumps

Steam Flow Meter:

- Veris-Acclelabar Model AFS with Foxboro IMV30 Multivariable Transmitter with remote mount, instantaneous steam flow rate (lbs/hr) and energy total (BTU x 100), and connectivity to Johnson Control Metasys or approved equal.

Chilled Water Meter:

- Onicon System-10-N2/BACnet Model F-3500 Featuring campus flow (gpm), instantaneous energy rate (KBTU/hr) and energy total (BTU x 100), and connectivity to campus Johnson Control Metasys or approved equal.

Steam Traps:

- Nicholson
- Spirex
- Armstrong

High-Pressure Steam Piping and High-Pressure Condensate:

- Thermal Pipe Systems Super Temp-Tite or approved equal

Condensate and Hydronic Water Piping:

- Metal Piping**:** Meeting ASTM A120 Grade A or ASTM A53 Grade A
- Metal Fittings**:** Meeting ASTM A234
  < 2-1/2" – screwed or compression fittings
  >2-1/2" – butt weld or compression fittings
- Metal Unions**:** Federal Specs WW-V-531 Type B less than 2"
- Metal Flanges**:** Meeting ASTM A181 Grade I (Forged carbon steel – weld neck)
- Gaskets**:** Compression type with spirotallic construction without asbestos
- Compression Fittings for Metal Pipe: Viega ProPress, Viega MegaPress, or approved equals
- Plastic Piping**:** ViegaPEX Barrier tubing or approved equal
- Plastic Piping Fittings: lead free Viega PEX PureFlow or approved equal
- Dielectric Nipples: Galvanized Steel
- Polypropylene piping system are not to be used.

Thermometers

- Weiss DVS35, Weiss DVU35, or approved equal

Valves

- Steam Valves (Under 40 PSI): Milwaukee 148 Series or approved equal
- Steam Valves (Over 40 PSI)**:** Sharp Series 3483 or approved equal
- Chilled Water and Heating System Valves**:** Wafer butterfly type – Demco, Nibco, Watts

Wall Hydrants

Freeze-proof and anti-siphoning from the following manufacturers:

- Zurn
- Woodford
- Watts
- Smith