SECTION 2

DIVISION 23

HVAC

DIVISION 23 - HVAC

Note: This is a guide for Designers only. Contents shall not be used in lieu of specifications as part of the Designer's contract documents.

SECTION 23 0510 - MECHANICAL GENERAL - HVAC

PART 1 - GENERAL

1.1 MECHANICAL DESIGNER:

A. Design for Accessibility and Maintainability. Mechanical systems and systems components shall be durable and easy to maintain. The Consultants shall incorporate into equipment and system design sufficient access and clearance for maintenance, repairs, and replacement. Incorporate instrumentation necessary for balance and initial adjustment, as well as for service and monitoring. Galvanized steel or concrete shall be used for outside mechanical equipment supports. Details of mechanical supports shall be shown on the drawings.

1. Rooftop equipment should be minimized to reduce roof damage and access requirement. A full stairs or elevator shall be extended to roof for maintenance of roof mounted major mechanical equipment such as air handlers, pumps and rooftop package units.
2. Location of all new equipment shall be planned to allow future replacement without major building modifications.
3. **Terminal units, control valves, dampers and BAS controllers shall be a maximum of 2 feet above ceiling grid.**
4. Hard ceilings access panels shall be a minimum of 24" square.
5. There will be no controllers or control components, such as air valves control valves etc, in the ceiling of a controlled access space. These components will be above the corridor or in an interstitial space.

B. Design for Reliability. Systems shall have a high degree of reliability. If an entire building system will be affected by lesser reliability of a component (for example, a pump serving building chilled water system), then a redundant piece of equipment shall be provided to increase overall system reliability. Design for parallel operation is acceptable for redundancy.

C. Design for Energy Conservation. The energy efficiency of building systems and equipment is an essential part of the University design philosophy. Any new project shall be designed with state of the art energy efficiency. Design will meet or exceed standards published by American Institute of Architecture (AIA), American Society of Heating Refrigeration and Air Conditioning Engineers (ASHRAE) and the State of North Carolina. Metering and Verification, and reporting of energy and water use is a designer requirement.

1. Major energy consuming systems and equipment shall be specified and purchased based on Life Cycle Cost Analysis. Careful evaluation of energy conservation measures shall begin early in the design phase and continue throughout the design process.
2. Building functions that require twenty-four hour a day operation, such as libraries, laboratories, computer rooms, and others as defined by the Owner shall be served by a system separate from that of offices or classrooms that are subject to different operating schedules.
3. Economizer Cycle that allows the use of outdoor air for free cooling during the winter and intermediate seasons without the use of mechanical refrigeration equipment, shall be specified. The Designer shall provide heat recovery for all systems using 100 percent outdoor air. All mechanical systems shall be controlled and monitored by a direct connection to FM Building Automation System as applicable.

4. Three phase electric motors for mechanical equipment shall be specified to be Premium Efficiency.
5. The Designer shall use variable volume air handling systems and variable volume pumping to optimize energy efficiency. Fans and pumps shall be selected with the highest efficiency available. Wire to water efficiency shall be evaluated for pumps prior to making the final selection.
6. The thickness of insulation for chilled water, hot water, steam, and condensate shall be geared toward conserving energy. Insulation thickness shall be selected for optimum cost versus efficiency. Economic evaluation is desirable.
7. Cooling towers shall be selected with fan motors or motors equipped with variable frequency drives to allow for energy efficient capacity control. Variable frequency drives will be located indoors.
8. Hydronic systems shall be designed with two-way modulating control valves to prevent energy waste. Minimum pump water flow requirement shall be maintained.
9. The Designer shall evaluate mechanical systems ENERGY EFFICIENCY not only at full load, but also at part load conditions using established computer models. The results shall be presented to the Owner. Energy use estimates shall be submitted with each design phase as well as with each alternate design proposal.
    a. For code applicable facilities, the Designer shall submit an energy model report indicating energy use expressed in BTUs per sq. ft. per year. The total energy consumption shall indicate monthly use of electricity, steam, water, cooling and heating BTU use from Regional Utility Plants and gas.
    b. Building consumption categories shall be further divided as practical to show energy use for lighting, motors, heating, cooling, production of domestic hot water, process loads and other major energy uses that may apply. The Owner can make an exception for small-scale projects.
    c. Designer will provide projected computer generated month to month usage of all different utilities for measurement and verification. Data files such as Trace .TAF are to be forwarded to both owner and commissioning agent.
10. After building acceptance by owner, M&V will be conducted quarterly during the first year of occupancy by the designer and reviewed by the Cx. Energy model will be calibrated quarterly and updated data files forwarded to the owner and Cx.

1.2 OWNER INTENT

A. HVAC Contract shall include:
    1. All heating connections and controls for domestic water heating equipment serviced by steam or heating-hot water. Domestic water heating equipment, cold water supply to this equipment and domestic hot water from this equipment, including connections and valves, shall be in the Plumbing Contract.
    2. Refrigeration and cold storage systems having capacity 15 tons and greater capacity. Systems of less than 15 tons may be placed in the General Contract.

1.3 DIVISION OF WORK

A. This section delineates the Division of Work between Division 23 (Plumbing and HVAC Contracts) and Division 26 (Electrical Contracts).
    1. Specific work to be done under Division 26 is hereinafter listed or described. All other work necessary for the operation of Division equipment shall be performed under Division 23.
        a. All individual motor starters for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 23 unless indicated as a part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished under Division 26.
        b. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box, trough, starter or disconnect switch. Under Division

26, line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections, shall be provided under Division 23.

c. Duct smoke detectors shall be furnished and wired by Division 26, installed by Division 23. Fire alarm AHU shut down circuits shall be wired from the fire alarm control panel to a termination point, adjacent to the fire alarm control panel, under Division 26. AHU control wiring from the termination point to the equipment will be under Division 23.

d. All relays, actuators, timers, programmable timers, alternators; pressure, vacuum, float, flow, pneumatic-electric, and electric-pneumatic switches; aquastats, freeze stats, line and low voltage thermostats, thermals, remote selector switches, remote push-button stations, emergency break-glass stations, interlocking, disconnect switches beyond termination point, and other appurtenances associated with equipment under Division 23 shall be furnished, installed and wired under Division 23.

e. All wiring required for controls and instrumentation not indicated on the drawings shall be furnished and installed by Division 23.

f. Roof exhaust fans with built-in disconnects provided under Division 23 shall be wired under Division 26 to the line side of the disconnect switch. A disconnect switch shall be provided under Division 26 if the fan is not provided with a built-in disconnect switch. In this case wiring from the switch to the fan shall be under Division 23.

g. The sequence of control for all equipment shall be as indicated on the Division 23 Drawings and specified in the appropriate section.

h. Where electrical wiring is required by trades other than covered by Division 26, specifications for that section shall refer to same wiring materials and methods as specified under Division 26. No Exceptions.

2. Many of the items covered in the mechanical guidelines pertain to those items which may be unique to The University of North Carolina at Charlotte, its mechanical systems or preference or requirements mandated by Facilities Management. Any item not specifically outlined or commented upon in these guidelines is left to the judgment of the engineering design professional to use current accepted good engineering practice. The construction documents are subject to review and comment by Facilities Management at any time during the course of design or construction of the project.

3. Deviations from concepts noted in these guidelines require approval of the Project Manager and Facilities Mechanical Engineer for The University of North Carolina at Charlotte. **RESIDENCE LIFE PROJECTS HAVE MECHANICAL VARIANCES GRANTED BY THE STATE CONSTRUCTION OFFICE.** Verify applicability prior to beginning design.

4. All floor plans and enlargements of floor plans shall bear North arrows, room numbers, and column lines conforming to the designations found on the Architectural floor plans. All floor plans and enlargements shall have the same directional orientation as the architectural floor plans. Site plans and floor plan directional orientation shall agree.

1.4 MECHANICAL EQUIPMENT ROOM DESIGN

A. New mechanical equipment rooms shall be designed to have access from the outside, via an opening large enough to facilitate the removal of the largest piece of equipment therein

B. All mechanical equipment shall be within Mechanical Equipment Rooms (MER). MERs shall be large enough to allow proper servicing of equipment, allow for future growth, and include access for replacement of all mechanical equipment.

C. The Consultant shall locate the MER to protect the surrounding areas from equipment generated noise. If sensitive spaces exist above or adjacent to a MER, acoustical treatment shall be provided to maintain noise level to acceptable limits as noted in ASHRAE.

D. The layout of equipment within a MER shall allow access to all equipment components, including pulling tubes for converters, chillers, and air-handling unit coils. A minimum of 3 feet is required for access to filters, dampers, and valves and as a separation between equipment. Lifting eyes shall be provided in equipment rooms in which the moving of heavy equipment is anticipated and for above ceiling equipment, such as an environmental room compressor, that will be mounted above the room enclosure.

E. MERs shall have space allocated within for storage of air filters and miscellaneous maintenance items.

F. MERs shall be provided with sufficient lighting that is not obstructed by ductwork or piping. Column and wall-mounted lighting shall be included where necessary.

G. All MERs shall be equipped with duplex convenience outlets suitable for operating small tools and drop-cord trouble lights.

H. Provisions for domestic water services for maintenance purposes shall be provided.

I. MERs located above the lowest floor shall have curbs around any equipment with water. The floor inside the curb will be sealed and a floor drain will be provided to prevent flooding the floor below.

J. All MERs shall be provided with adequate ventilation and temperature control designed to prevent temperature buildup and freeze up.

1.5 ADDITIONAL REQUIREMENTS FOR DRAWINGS

A. Capacity of new equipment shall be described on drawings by way of equipment schedules. Equipment schedules shall indicate, in addition to technical data, the location of equipment and areas served by it. Schedules for air-handling units shall indicate minimum and maximum outdoor airflow in cubic feet per minute in addition to other information.

B. Ductwork layouts on 1/8" and 1/4" scale drawings shall be shown as a double line, drawn to scale. Single line duct layouts will be acceptable only on preliminary drawings.

C. Flow diagrams for air, water, and steam shall be shown on drawings with all piping sized. Direction of flow shall be indicated. The Consultant shall incorporate schematic piping diagrams for the following:
1. Chilled water systems
2. Condenser water systems
3. Hot water systems
4. Converters
5. Pumps
6. Heating and cooling coils
7. Steam main drips
8. Flash tanks
9. Pressure-reducing stations
10. Domestic hot water heaters
11. Cooling towers
12. Others as they may apply to a specific project

D. Piping and ductwork sizes shall be clearly indicated. All valves shall be shown, as well as volume dampers in ductwork, fire and smoke dampers, and access doors and must conform to accessibility and maintenance standards.

E. Mechanical equipment room layouts shall be drawn in 1/4" scale or larger. As many sections as necessary shall be provided to clarify installation of equipment, piping, and ductwork, and to show clearances for service. All large valves, particularly gate valves, shall be drawn to scale showing the location of the hand wheels.

F. The automatic temperature control schematic shall be shown on drawings. Sequence of operation description shall be provided either on plans or specifications.

G. Control valves shall have a valve authority of at least 0.25 unless approved by the Facilities Engineer. A control valve schedule shall be provided showing valve authority for all control valves larger than ¾". For terminal reheat control valves a typical valve authority is sufficient.

PART 2 - PRODUCTS

2.1 LABELING

A. Mechanical equipment shall be labeled with name, number as designated on designer's contract documents, service and operational requirements, design capacity, and other design parameters such as pressure drop, entering and leaving conditions, rpm, etc. Ductwork shall be identified as supply, return, exhaust, intake, or relief with signs and arrows showing service and direction of flow. Pipe shall be identified with colored signs and arrows indicating its respective system and direction of flow.

B. Strap on Plastic Pipe Markers: Factory fabricated, flexible, semi- rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed. Install tags with corrosion resistant chain.

C. Laminated Plastic Name Plates: ASTM D 709, Type I, cellulose, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white melamine subcore. Nameplates shall be approximately 1-1/2" x 4", 1/16" thick, and have 1/2" high lettering. Face of plastic shall be black with white letters. Fasteners shall be self-tapping, stainless steel screws or contact-type with permanent adhesive.

D. Metal Tags: Polished brass, 0.032" thick, with stamped letters; tag size minimum 1-1/2 inch diameter.

E. See Div 09 9100 for paint general requirements. New equipment will be pre-painted by the equipment supplier before shipment. Colors (to be submitted to Owner for approval) for equipment and piping color schedule shall be as follows. Devoe paint identification number is provided for reference only. Other manufacturers matching the paint and color should be considered.

Piping System	Pipe Abbreviation	Paint Color (Devoe)
Acid Waste	ACID	Safety Yellow (DC9400)
Chilled Water	CHW (S, R)	Safety Blue (DC 9800)
Chilled Beam Water	CB(S, R)	Car Blue (DC4035)
DI	DI(R)	Green
Condenser Water	CW (S, R)	Car Blue (DC4035)
Hot Water (heating)	HW (S, R)	Oxide Yellow (DC8800)
Gray Water	GW (S, R)	Purple
Rain Harvesting	RH (S, R)	Purple
Steam	S (HPS, MPS, LPS)	Safety Yellow (DC9400)
Steam Condensate	LPC, HPC	Safety Orange (DC9200)
Pumped Condensate	CPD	Oxide Red (DC7821)
Natural Gas	GAS (FG, ID)	Medium Yellow (DC 8600)
Relief Valve Vents		Orange
Duct work		White
Equipment		White
Hanger Rods		Flat Black
Domestic Cold Water	DCW	Medium Green (DC6650)
Non-Potable Cold Water	NP CW	Spruce (DC5323)
Lab Cold Water	LCW	Light Green (DC5574)

Domestic Hot Water	DHW	Light Buff (DC1810)
Lab Hot Water (S, R)	LHW	Interna'l Orange (DC6900)
Lab Vacuum	LV	Blue
Lab Waste	LW	Black (DC9903/9990)
Tempered Water	TW	Medium Brown (DC1400)
Domestic Hot Water Return	DHWR	Desert Sand (DC1046)
Lab Compressed Air	LA	Plymouth Grey (DC2100)
Nitrogen	N2	Light Grey (DC2973)
Sanitary Drain / Vent	SAN	Match Surrounding
Sprinkler / Fire Line		Safety Red (DC9000)

F. Identify piping, concealed with plastic pipe markers using the same color coding identified for exposed piping in mechanical room. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.

G. Identify piping with marker system. Markers shall be "snap-on" or "strap-on" type depending on applicable pipe size.
1. For pipes up to 1" diameter, use 1 inch letters.
2. For pipes 1-1/4" to 2" diameter, use 2 inch letters.
3. For pipes 2-1/2" to 6" diameter, use 3 inch letters.
4. For pipes over 6" diameter, use 4 inch letters.

H. Identify pumps, air handlers, chillers, cooling towers, package units, heat transfer equipment, tanks, and water treatment devices with stencil painting. Small devices, such as in-line pumps, may be identified with tags.

I. Identify control panels and major control components outside panels with plastic nameplates.

J. Provide minimum ¾' stick-on dots on the ceiling grid for identification of equipment hidden above ceiling. Color code as follows:
1. Yellow - HVAC equipment
2. Red - Fire dampers/smoke dampers
3. Green - Plumbing valves
4. Blue - Heating/cooling valves

2.2 VALVES

A. All valves shall be provided with 0.032" thick polished brass valve tags with the stamp-engraved piping system abbreviation and sequenced valve numbers. Valve tags shall be attached with brass chains or S-hooks. Valve numbers shall be coordinated with other trades and any existing valves to avoid duplication of numbers.

B. Valve schedules shall be mounted in glazed display frames at the facility and shall include valve number, piping system, system abbreviation (as shown on valve tag) and location of valve (room and space). Valves intended for emergency shut-off and similar special uses shall be marked by "flags" in the margin of the schedule.

2.3 UNDERGROUND UTILITIES

A. TRACER WIRE BOXES: Plastic gas and water services longer than 1000 feet in length from curb valve to meter riser must have tracer wire boxes installed in accordance with UNC Charlotte standards.

B. All underground piping and utilities (both metallic and non-metallic), except copper pipe, shall have a separate copper tracer wire and non-metallic warning tape installed above the utility line.

C. The tracer wire shall be traced for continuity prior to backfill, immediately upon completion of backfill and compaction and once again during final utility location/as-built at the end of the project. This also will include landscape irrigation mains to the points of the valves. All above ground utility features such as vaults, manholes, valves, handholds, etc to be properly labeled. Contractor shall provide an inventory of all installed outdoor utility features including type and model.

D. Identification Tape: The 1st stage of identification shall be a buried warning tape. This tape shall provide an early warning at shallow depth excavation. The tape shall be 6" wide, and buried approximately 18" to 30" above the service pipe, but a minimum of 10" below finished grade. It shall consist of multiple layers of polyethylene with an overall thickness of 3 to 5 mils. It shall be installed continuous from valve box to valve box or manhole to manhole, and shall terminate just outside of valve box or manhole wall. The black colored lettering on the warning tape shall be abrasion resistant and be imprinted on a color-coded background that conforms to APWA color code standards. The lettering on the tape should name the utility it is protecting. (i.e. Caution Buried Sewer Line Below).

E. TRACER WIRE: The 2nd stage of identification shall be a buried tracer wire. This tracer wire shall provide pipeline identification, be fully detectable from above grade utility locators, and be able to provide a depth reference point to top of pipe.

F. All pipe, including lawn irrigation lines, and metallic pipe with compression gasket fittings installed underground shall have a tracer wire installed along the length of the pipe. The wire shall be taped to the bottom of the pipe at a maximum of 10' intervals and not allowed to "float freely" within the backfill.

G. Tracer wire shall be single-conductor, 12 gauge minimum, copper single-conductor wire with type "UF" (Underground Feeder) insulation, and shall be continuous along the pipeline passing through the inside of each valve box. A #12 AWG or heavier (smaller AWG number), solid, insulated (RHW, THW, or polyethylene insulation is recommended), copper wire shall be taped to pipe at 10 foot intervals. Do not wrap wire around pipe. The wire must be one continuous, unbroken length. Coil tracer wire at meter location and street end with enough wire to extend a minimum of two feet above grade

2.4 METERING

A. The University operates utility distribution systems for electricity, potable water, steam/ condensate, hot water and chilled water. Natural gas is provided by Piedmont Natural Gas Co. Cost distribution for utilities is accomplished through a metering system and a prorated assignment of cost.

1. Steam costs are generally allocated based on metering steam or condensate at the building. Each building shall be provided with a steam meter and/or a high temperature condensate meter designed for this severe service. Provide a meter of appropriate capacity on the discharge side of the condensate pump and include isolation valves, meter bypass, a square head rate cock to control flashing, and a digital pickup to interface with building automation system. Should a particular application require actual metering of the steam flow, insertion type meters of appropriate design should be provided. Meters must be approved for interface to the FM Utilities Monitoring System.
2. Potable Domestic Water metering shall be by turbine or nutating disk meter with magnetic drive. Meter to be located in mechanical room, easily accessible, read in cubic feet, and provide output to building automation. Verify adequate turn down ration is provided with the meter for measurement at low flow.
3. Non-sewered water (consumed but not returned to the sewer, e.g. irrigation, cooling tower makeup, etc.) should be metered at its source. Meter should be located in mechanical room, easily accessible, read in cubic feet and provide output to building automation. Meters and transmitters must conform to CMU standards for providing sewer credits.

4. Chilled water or hot water (where pumped to another facility through a loop system) flow, temperature differential and energy consumption shall be measured and calculated for both the main building and the isolated structure. Output shall be in BTUH or Ton hours, be available at the BTU Meter, and be integrated to the building automation. Flow in GPM will be monitored. BTU meters shall be Onicon 10 with F3500 insertion magnetic flow sensor or approved equal.
5. Natural Gas metering shall comply with all requirements of Piedmont Natural Gas, and interface to the building automation system for monitoring gas usage in Therms and CFH. Controls contractor is required to integrate the meter with building automation system. Verify if gas usage in building for certain users needs to be metered and monitored separately for billing purposes.
6. Power Monitoring Interface: The Power Measurement Interface (PMI) device shall include the appropriate current and potential (voltage) transformers. The PMI shall be certified under UL-3111. The PMI shall perform continuous true RMS measurement based on 32 samples-per-cycle sampling on all voltage and current signals. The PMI shall provide outputs to the BAS based on the measurement and calculation of the following parameters:
   a. Current for each phase and average of all three phases,
   b. kW for each phase and total of all three phases,
   c. power factor for each phase and all three phases,
   d. Voltage for each phase and average of all three phases , and
   e. Power consumption (kWH).

   These output values shall be communicated to the BAS over the open-protocol LAN. Coordinate with electrical engineer to ensure electrical specifications require correct meter to accomplish power monitoring noted above.

   Mount to allow manual reading without use of ladders.

2.5 VARIABLE FREQUENCY DRIVES

A. Variable Speed Drive systems manufacturer shall provide a Modbus RTU, BacNet MSTP or LonWorks interface to the controls Building Automation System (BAS). Data available to the BAS must include all commands (on, off, speed) and status, control setpoints and zone process variables, and controller alarms. Integration of data to the BAS is the responsibility of the Control Systems Integrator.

B. Variable frequency drives will be located indoors, unless approved by the University.

C. Provide a manual bypass consisting of a door interlocked main fused disconnect padlockable in the off position, a built-in motor starter and a four position AUTO/OFF/LINE/TEST switch controlling three contactors.

D. Phase loss protection modules shall monitor incoming 480V, 3-phase power and interrupt 120V control circuit. Phase loss protection shall be installed inside the VFD cabinet.

E. Provide interlock to motor disconnect switch to prevent VFD damage.

F. Drive rated motors shall be provided with grounding rings.

2.6 SOUND AND VIBRATION CONTROL

A. Outdoor Equipment such as Cooling Towers, fans, and Air-cooled condensers shall be provided with low noise technology.

B. HVAC equipment located in the building shall be carefully evaluated for sound level. If sound levels are expected to be higher than recommended in ASHRAE guidelines, sound control devices are required.

C. The Consultant shall determine the type of acoustical treatment that might be required. In general, all larger air-handling units will require sound attenuators in ductwork for both the supply and return fans. Some mechanical equipment rooms might require lightweight acoustic materials for walls to isolate equipment noise from the rest of the building.

D. Acoustic lining is not an acceptable standard for duct systems. The Consultant shall provide other means of sound attenuation. Any use of acoustic lining in low pressure duct systems will require approval by the University Facilities Mechanical Engineer.

E. Room terminal units such as variable volume terminals shall be selected for low sound levels. Air supply diffusers and registers shall have sufficiently low air velocity to meet low sound criteria.

F. Air noise from a supply outlet is not acceptable. Outlet dampers are for “fine tuning” only. Provide dampers at the branch takeoff.

G. The Consultant shall provide vibration isolation where required. There shall be no objectionable transmission of vibration from equipment to the building structure.

H. Appropriate vibration isolation of equipment, piping and ductwork shall be specified. Attention shall be paid to the proper use of flexible duct and pipe connectors, the use of resilient pipe hangers and supports, anchors and guides, and the treatment of pipe and duct penetrations through building walls.

I. Mechanical equipment rooms shall be placed preferably at ground level and away from occupied spaces to minimize transmission of vibrations and noise into the building.

J. Fan wall system shall be utilized for critical noise and vibration isolation application.

SECTION 23 0518 – METERS AND GAUGES

PART 1 - GENERAL

PART 2 - PRODUCTS

A. Electromagnetic Flow Meter: Insertion type flow meter for monitoring chilled and hot water flow shall be similar to Onicon model F-3500. The turn down ratio will exceed 80:1.

B. BTU Meters: Shall be Onicon System 10 or equal.

C. Steam Flow Meter: Shall be inline style vortex flow meter. Sensor shall have no moving parts. The sensor shall utilize a separated vortex bluff body and a sensor wing with a dual piezoelectric sensing technology to ensure maximum signal to noise rejection. The piezoelectric sensor shall be removable under steam pressures of up to 750 psig without steam shutdown. The flow meter electronics shall be microprocessor based. Meter shall be similar to EMCO model PhD.

D. Glycerin-Filled Pressure Gauge: 4-1/2” dial with stainless steel or cast aluminum case, Plexiglas Lens, stainless steel movement, Polypropylene blow-out back plate, White scale with black divisions and numerals. Range for the gages shall be selected for type of service.

E. Bimetallic Thermometers: 5” Dial type thermometers with stainless steel case, adjustable angle with front recalibration, bimetallic helix actuated with silicone fluid damping, white with black markings and black pointer hermetically sealed lens, stainless steel stem. Range for the thermometers shall be selected for the type of service.

SECTION 23 0520 - HVAC PIPING, VALVES & ACCESSORIES

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. The Designer shall clearly indicate the service for which pipe is intended when specifying pipe material. A schedule shall be provided that identifies pipe material and pressure class, application, methods of joining, fittings, and other relevant information.

B. Appropriate devices for piping expansion shall be provided. Expansion joints, guides, and anchors shall be indicated on drawings. The Designer is responsible for calculating pipe stresses and location of anchors.

C. The Consultant shall provide for positive means of draining and venting the piping system.

D. Valves shall be provided to allow for isolation of branch piping and risers.

E. Valves mounted 12’ or greater AFF, or inaccessible by an 8’ ladder, shall have a chain operator.

F. Balancing valves shall be provided to facilitate system testing and balancing.

G. Pressure taps on each flow-measuring device shall be extended outside of the insulation. Measuring devices shall be clearly indicated and at least one flow meter shall be provided.

H. Welding procedures and requirements for welders’ qualifications shall be clearly described in the specification.

I. Pipe hangers and supports shall be selected to prevent pipe bending and deflection and to eliminate the transmission of vibration to the building structure.

J. Piping shall be color-coded and labeled according to Labeling paragraph 2.1 E. Color chips shall be provided to the Owner for approval.
   1. All cold service insulated pipe (chilled water, interior condenser water lines, interior domestic cold water) to have rust inhibitive prime coat applied before insulation.
   2. All uninsulated pipe or bare metal to have rust inhibitive primer plus minimum 2 finish coats of approved color.

2.2 HEATING HOT WATER AND CHILLED WATER PIPING BELOW GRADE

A. Piping shall be factory fabricated and insulated by Rovanco, Perma-pipe or Thermacor.

B. Carrier Pipe: Carrier Pipe will be black carbon steel pipe conforming to ASTM A-53 Grade B Schedule 40. Pipe will be joined by welding to ANSI B.31.1 Code for Pressure Piping.

C. All pipe and fittings will be insulated with polyurethane foam.

D. All fittings will be factory prefabricated and insulated at pre-insulators plant.

E. Jacketing Material shall be extruded black high density polyethylene (HDPE). The jacket throughout the entire system shall incorporate electric fusion, butt fusion or extrusion welding at all fittings, joint closures or other points of connection prohibiting the ingression of water.

F. Moisture Barrier End Seals shall be factory applied, sealed to the jacket and carrier pipe. End seals shall be certified as having passed a 20 foot head pressure test. End seals shall be high temperature mastic completely sealing the exposed end of the insulation. Field applied ends seals shall be installed at any field cut to the piping before continuing with the installation.

G. Piping shall meet H-20 Highway loading with 24” of backfill is provided on top of pipe.

H. Flushing of piping 4" and larger shall utilize high-pressure "hydro-jet" processCoordinate the limitations and requirements of hydro-jet process with the flushing subcontractor such that the piping is installed in a sequence and manner that allows every section of the new pipeline to be cleaned and flushed. Limitations may include maximum length of the pipe section, maximum number and/or degree of bends in the pipe section, maximum slope of the pipe section, equipment and excavation access requirements, and the minimum size of the openings required in the piping to allow for insertion and retraction of the cleaning head.

I. Provide a by-pass valve on high-pressure steam line isolating valves.

J. Butterfly valves shall be of the positive shut-off type.

K. All water valves to operate by turning the square nut clock-wise (right) to close and counter-clockwise (left) to open, as per UNCC requirements.

L. Provide all valves below grade with extensions and donut and valve box, when grade at location is altered.

SECTION 23 0593 - HVAC TESTING, ADJUSTING & BALANCING

PART 1 - GENERAL

PART 2 - PRODUCTS

PART 3 - EXECUTION

3.1 TESTING ADJUSTING AND BALANCING

A. Testing, Adjusting, and Balancing (TAB) shall be completed by an independent balancing company certified by AABC or NEBB.

B. The TAB contractor shall be a sub-contractor to the CM at Risk or as designated by the owner.

C. TAB shall be completed and the report shall be approved by the designer before the final inspection. The approved TAB report shall be available at the final inspection for State Construction review.

D. The designer shall coordinate with the TAB contractor to spot check air and/or water flows.

SECTION 23 0700 – HVAC INSULATION

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 INSULATION FOR PIPING SYSTEMS

A. Steam and Condensate Piping Above Ground: Provide fiberglass or foamglass insulation.

B. Steam and Condensate Piping in Manholes: Provide foamglass or calcium silicate insulation.

C. Heating Hot Water: Provide fiberglass insulation.

D. Chilled Water: Provide closed cell elastomeric or rigid foam insulation. Fiberglass insulation is not acceptable for chilled water duty.

E. Condenser Water Exposed to Weather: Provide rigid foam insulation.

F. Makeup water: Provide closed cell elastomeric insulation.

G. Refrigerant Piping: Provide elastomeric insulation (Armaflex or Equal).

PART 3 - EXECUTION

3.1 INSULATION FOR DUCT SYSTEMS

A. All supply and return air ductwork shall be insulated. It is suggested that insulation density for supply duct be not less than 3 pounds per cubic feet. Due to indoor air quality concerns, supply and return ductwork shall be wrapped with insulation, rather than internally lined. However, if noise transmission from the fan is a concern, designer may specify insulation liner only to the extent necessary to achieve the sound control desired.

B. In occupied areas without hung ceilings where insulated ductwork is visible, double wall ductwork with solid liner will be used.

C. Ductwork exposed to the weather that requires exterior insulation will be insulated with polystyrene board insulation. 0.016” thick Aluminum jacket will be provided on insulation. Fiberglass insulation will not be accepted.

D. Canvas finish on ductwork insulation shall be provided in all spaces where it might be subject to damage, such as in equipment rooms.

E. All ductwork in unconditioned spaces shall be provided with vapor-retarding finish.

F. Asbestos abatement design for renovation projects will be provided in the contract documents.

3.2 INSULATION FOR PIPING SYSTEMS

A. Provide 0.03” PVC jacket on all piping other than steam exposed to view in mechanical room and occupied spaces

B. Provide 0.016” aluminum jacket on all insulated piping exposed to outdoors and in manholes. Provide electrical heat trace on piping prior to insulating the pipe exposed to outdoors.

C. Provide canvas jacket on steam piping exposed to view in mechanical room and occupied areas.

D. Provide aluminum jacket on steam piping in manholes.

SECTION 23 0800 - MECHANICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 REQUIREMENTS

A. North Carolina General Statute 143-135.37(d) requires commissioning of major projects.

B. Performance Verification. – In order to be able to verify performance of a building component or an energy or water system component, the construction contract shall include provisions that require each building component and each energy and water system component to be commissioned, and these provisions shall be included at the earliest phase of the construction process as possible and in no case later than the schematic design phase of the project. Such commissioning shall continue through the initial operation of the building. **The project design and construction teams and the public agency shall jointly determine what level of commissioning is appropriate for the size and complexity of the building or its energy and water system components.**

C. Design for Commissioning. The mechanical designer will be responsible for ensuring and developing "… a systematic process of assuring that a building (*mechanical, electrical and plumbing systems*) performs in accordance with the design intent and the owner's operational needs." The Owner considers the following elements as a minimum requirement for building acceptance and inherently integral to the Mechanical Designer responsibilities, unless specifically notified otherwise by the Owner.

1. Design Phase – Provide documentation to the commissioning agent with copy to owner for following:
    a. Owner's project requirements and Basis of Design, to include single line drawings for Design Narrative.
    b. Commissioning reviews of design documents.
    c. Verification that operations and maintenance staff training through the mechanical contractor is specified.
    d. Building load data files and energy analysis data for Measurement and Verification requirement.
    e. Metering and sub metering to accomplish analysis of annual energy consumption versus projected energy consumption.
    f. Coordinate controls review with Commissioning Agent. Controls Contractor and Designer to verify understanding of all parties as to control sequence of operation and design intent. Clarify the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

2. Construction Phase
    NOTE: Commissioning shall in no way reduce the designer scope and responsibility for Construction Administration to include verifying quality of system installation. Designer team is to:
    a. Attend the commissioning scoping meeting and selected commissioning team meetings.
    b. Provide Installation Verification.
    c. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
    d. Perform normal submittal review, construction observation, as-built drawing preparation, etc., as contracted. On site observations should be completed just prior to system startup.
    e. The designers shall continue to assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the

specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.

f. Startup and Checkout.

g. From the Contractor's red-line drawings, edit and update one-line diagrams developed as part of the design narrative documentation and those provided by the vendor as shop drawings for the chilled and hot water, condenser water, domestic water, steam and condensate systems; supply, return and exhaust air systems and emergency power system.

h. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.

3. Post Construction Phase

a. Designer will provide classroom overview to university operations staff to include Basis of Design, chilled and hot water systems, air distribution systems, emergency operations, system capacities and limitations, and metering.

b. M&V. Assist in reconciling discrepancies between actual energy usage and the submitted projection model.

D. The Designer will include in bid documents the specific support and documentation required of the General Contractor (CM), Mechanical Contractor, Electrical Contractor, Plumbing Contractor, Controls Contractor, Designer, Owner and others as applicable to ensure acceptable commissioning.

Reference Division 01 General Requirements for commissioning guidelines. **Guidelines will be modified as appropriate for each project.**

SECTION 23 0900 - AUTOMATIC TEMPERATURE CONTROLS

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 SYSTEM

A. Building Automation System:

1. The control system shall be fully compatible with the existing campus Building Automation System (BAS). The existing system is web-based Tridium. The new system shall have full control capability through the existing server. All systems must be completely and seamlessly programmable through the Tridium server. Systems that require additional computers or software to program and control will not be acceptable.

2. The Contractor must provide the cost for the complete integration of the new system open protocol controller and / or gateway to the existing system interface, to include utilities monitoring and interface to the Tridium software.

B. Control valves shall be sized so that the pressure drop across the valve at is at least 30% of the coil pressure drop at full design flow. Control valves shall have a valve authority of at least 0.25 unless approved by the Facilities Engineer. A control valve schedule shall be provided showing valve authority for all control valves larger than ¾". For terminal reheat control valves a typical valve authority is sufficient

C. Contact owner for updated controls integration specifications.

SYSTEM FEATURES AND ARCHITECTURE (an overview)

1. UNC Charlotte intends to monitor and control the entire system from an existing browser-based Facility Management System (FMS). A Niagara AX server is located in Physical

Plant. It is the intent of the University to integrate this project and all future campus direct digital control systems to this Niagara AX server using the competitive bid process. The entire FMS system including the products and labor detailed in specifications shall be provided by one of the acceptable control system integrators. Provide the appropriate number of Niagara AX based NAC(s) to integrate DDC system as necessary. NAC(s) to be JACE 7 series. Hard drives are not acceptable.

2. The scope shall include HVAC control and tuning, electrical, gas and water metering, energy management, alarm monitoring, and all trending, reporting and maintenance management functions related to normal building operations.
3. Power Fail Protection - All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the ASC or FPC.
4. The supplied system must incorporate the ability to access all data using Java enabled browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage.
5. UNC Charlotte access to the FMS shall be via a standard Internet browser from a remote location utilizing VPN, from a standard browser within the campus network or from a local workstation by direct connection to the Campus LAN. The Control Systems Integrator must provide a connection from every Network Area Controller (NAC) to the campus network to enable this access.
6. Provide integration of the new engineered systems such as Variable Speed Drives, new Variable Speed Pumping Systems, Chillers, etc. via a Modbus, Lon or BACnet interface provided by the equipment manufacturer. Provide graphics at the FMS to visualize the appropriate information from these systems.

SECTION 23 2213 – STEAM PIPING

PART 1 - GENERAL

1.1 STANDARD

A. The University of North Carolina at Charlotte operates a Steam Plant which provides nominal 100 psig steam to the campus. Steam Plant is operational September 15 through May 20 of each year. May 20 to September 15 is reserved for scheduled maintenance and repairs of the steam system. Satellite boilers are operated during the Steam Plant shutdown to provide the minimum steam support required by the campus.

B. All 125 psig steam distribution system piping, valves, fittings, flanges, etc. shall be rated at 250 psig up to and through the first reducing valve. Steam condensate piping and fittings shall be schedule 80. Steam line gaskets shall be Flexatallic brand.

PART 2 - PRODUCTS

2.1 UNDERGROUND DISTRIBUTION SYSTEM

A. Manholes will be a minimum of 8 ft x 8 ft internally. Wall penetrations will use high temperature Link-Seals. Drains will be provided. Provide cast iron gravity drains to the nearest storm sewer. Use sump pumps only where gravity drains are not possible. Two access points will be provided for each manhole. Provide two manhole covers (16” over sump pit and 24” over ladder) on each steam manhole for egress and ventilation. Covers shall be reinforced for vehicle loads and set at grade or provided with a minimum of 24” soil cover where required to be below grade, such as a playing field. Provide galvanized steel ladder to 6” below cover in lieu

of cast-in-place steps. Show detail of knockout panel for future line connections. Run rebar through knockout panel. Indicate sump location.

B. Replacement underground piping will be direct burial, preinsulated steel piping. The system shall be Thermafab HT 406 manufactured by Thermacor Process, Inc., of Fort Worth, Texas, or equal, suitable for 406 degree F.Carrier pipe shall be steel ASTM A-106, Grade B seamless. Steam line shall be Sch 40, condensate line to be Sch 80 seamless. Jacketing material shall be High Density Polyethylene (HDPE) with electric-fusion pressure-testable joint closure. HDPE shall have minimum wall thickness of 150 mils. Pre-engineered systems shall be provided with all straight pipe and fittings factory preinsulated and prefabricated to job dimensions. Expansion/contraction compensation will be accomplished utilizing factory prefabricated and preinsulated expansion loops or elbows. End seals shall be factory applied.

2.2 STEAM VALVES

A. Steam Service Isolation Valves (2 ½" and Smaller): Carbon steel Klinger, Bonetti or equal piston valves ANSI 300 flanged. Flanges shall be according to ANSI B 16.5, class 300." Valves shall have extension rod adapters and extension rods to grade.

B. Steam Service Isolation Valves (3" and larger): Valves shall be Triple Offset Butterfly Valves - Quarter turn, metal to metal seated, utilizing "inclined conical sealing" to create torque seating effect. Valves shall have bidirectional bubble tight shutoff in accordance with ASME B16.34 and B31.3. Valve bodies shall be double flanged, cast steel with face to face dimensions conforming to ISO 5752, series 14 class 300. Valves discs shall be 316 SS. Valves shall be equipped with machined registered pinned brackets. Valves shall have graphite packing with minimum of four studs for precision adjustment. Valve seat shall be a minimum of three (3) layers of stainless steel with laminated graphite between rated to 932 degrees F. Actuators shall be heavy-duty gear operators. Valves shall have extension rod adapters and extension rods to grade. Valves shall be similar to Adams, Xomax series 9000, Vanessa 3300.

C. Gate Valves for equipment isolation: Cast Steel body, CA-15 disc, bolted bonnet, rising stem, handwheel with field fabricated stem extension to grade, OS&Y, hardfaced seat rings, flanged ends, 300 SWP, Crane Fig. 33 or equal

D. Gaskets: Gaskets at all flanges shall be carbon steel spiral wound with graphite filler material, Garlock Flexseal RW or equal. Gaskets are to be compressed to manufacturer's recommendation. Bolts will be ASTM A193 GR B7, nuts will be ASTM A194 GR 2H. Provide hardened steel washers under nut and bolt shoulder. Torque to manufacturer's recommendation for 250 psig saturated steam service. Bolts, nuts, and washers are to be lucbricated with non-metallic lubricant (oil and graphite). Provide documentation of manufacturer's recommendation to University project manager.

E. Manhole Modification: Core drill roof of manhole in line with valve extensions to allow valve operation from outside manhole. Provide metal valve box with extension and seal to prevent water leakage into manhole.

F. Provide a by-pass valve on high-pressure steam line isolating valve.

G. Steam pressure-reducing stations shall be designed to be two stage. Valves and fittings rated at minimum 250 SWP shall be used upstream of steam pressure reducing valves (PRVs). All PRVs shall be selected such that generated noise does not exceed 80dba.

H. Steam condensate shall be pumped back to the steam plant. The Designer shall specify steam powered condensate pumps in all locations where HP steam is available.

SECTION 23 6000 - HVAC EQUIPMENT

PART 1 - GENERAL

1.1 ELECTRICAL REQUIREMENTS

A. Motor, controllers and other special equipment are sometimes provided and installed by other trades. This section specifies typical connections to that equipment.

B. All individual motor starters or VFD's for mechanical equipment (fans, pumps, etc.) shall be furnished and installed under Division 23 (Mechanical Contractor) unless indicated as part of a motor control center. Motor starters for mechanical equipment provided in motor control centers shall be furnished under Division 26 Electrical Contractor. Under Division 26, power wiring shall be provided up to a termination point consisting of a junction box. Trough, starter, VFD or disconnect switch. Under Division 26 line side terminations shall be provided. Wiring from the termination point to the mechanical equipment, including final connections shall be provided under Division 23.

C. Where unscheduled junction boxes are used by Contractor to facilitate wiring or to comply with limits of elbows and bends, they shall be concealed if at all possible to do so and still be left accessible. If this is impossible, they shall be recessed in walls or ceilings and provided with an oversized cover which shall be painted out to match adjacent surfaces. If it is necessary to mount such boxes exposed, the location shall be approved by the Engineer.

D. All contactors, motor starters and combination type starters specified shall be equipped with Hand-Off-Automatic switches, pilot (run indicating) light, 120 volt control transformer, and two sets of auxiliary contacts. The switch and light shall be located on the unit cover. Starters shall be Square D, Cutler-Hammer, General Electric Co., or equivalent by others.

E. All safety switches shall be heavy-duty type, NEMA 1 for indoor and NEMA 3R for outdoor use unless specifically stated otherwise. They shall be fused type unless specifically indicated otherwise on plans. Fused type shall be equipped with Bussmann Fusetron type fuses, or approved equivalent. Switches shall be by Square D, Cutler-Hammer, General Electric Co., or equivalent by others.

F. All safety switches, motor starters, or other boxes or panels, designated as NEMA 3R or otherwise intended for outdoor use or use in wet areas, shall use rain tight conduit hub fittings with bonding screw.

G. Control wiring shall not be installed in the same raceways as power wiring.

H. VFD’s shall have interlocks with disconnects to prevent damage when motors are disconnected.

I. VFD rated motors shall have grounding rings.

PART 2 - PRODUCTS

2.1 COOLING TOWERS

A. Cooling towers shall be located in such a way as to have sufficient unobstructed space to allow for adequate air supply for tower fans. Care shall be taken to prevent possible air recirculation and impacts on adjacent building structures.

B. Cooling tower location shall be as near as practical to level conditions and as close as possible to the chillers and pumps to minimize pumping costs.

C. Tower locations shall be as far as possible from trees and other foliage. Any alterations to the campus grounds to accomplish this shall be coordinated with the FM Grounds Department.

D. Screens shall be provided on tower intakes to keep debris and leaves out of tower sump. Balancing valves at hot water basins, extended lube lines and stainless steel cold water basins are required. Provide stainless steel cold and hot water basins, sump and plenum walkway (service platform).

E. If two or more towers are operated in parallel, an equalizing line that connects the tower sumps shall be provided to balance water distribution. For towers with more than one cell, positive shut-off valves shall be provided to allow for cell isolation during maintenance shutdown. Equalizer lines are required for multiple cell towers. If control valves are used to isolate cell for water cooled equipment to operate with particular cell(s), control valves shall be provided in cooling tower supply line to isolate non-operating tower sump from the operating tower pump.

F. Provide hot water basins with dams for low flow operation.

G. Noise level shall be an important consideration in the selection of cooling towers. Provide low noise fans.

H. Cooling towers shall be selected with variable frequency drives to allow for energy efficient capacity control. All cooling towers shall be provided with appropriate ladders with safety cages, railings at the top of the tower, and access platforms for maintenance.

I. Cooling towers will be induced draft, crossflow design with gear drive or counterflow design with belt drive. Motors shall be out of the air stream if installation allows.

J. Cooling tower cold water basin shall be provided with sump sweeper piping complete with spray nozzles. Cooling tower filtration system shall be provided using the sweeper piping.

2.2 AIR HANDLING UNITS

A. The use of multi-zone air-handling units, spray coil systems, and ceiling-mounted fan coil units is not acceptable in new construction. For small renovation projects, an exception can be made if the need is substantiated. No fan coil units shall be installed concealed above ceilings without prior approval of the university Facilities Mechanical Engineer.

B. Air-handling units that use 100 percent outdoor air shall be equipped with preheat, cooling and reheat coils to allow dehumidification control. If 100 percent outdoor air is used in air-handling units because of high exhaust requirements, such as in laboratories, heat recovery from exhaust air is required. Non-contaminating and low-maintenance heat recovery technology shall be used. Examples are ceramic heat wheels, phase change heat transfer, and coil loops.

C. Units using more than 20% outdoor air will be provided with static air blender section.

D. All large, central station air-handling units shall be equipped with stainless steel drip pans and moisture eliminators. The IAQ drain pan shall be double pitched to allow for complete condensate removal and shall be accessible for maintenance.

2.3 CHEMICAL WATER TREATMENT

A. Contact university Facilities Mechanical Engineer for specific requirements.

B. Conductivity controller provided with cooling tower systems shall be Lonworks compatible and communicate on Modbus, Ethernet or Bacnet with the DDC controls system used for the project.

C. Cooling tower make up water will be metered. Verify type of water meter to be used if credit is to be claimed from CMUD.

D. Provide pot feeders for closed loop systems.

E. Provide coupon rack for cooling tower water treatment.

2.4 CHILLED WATER SYSTEMS

A. The desired cooling medium for air conditioning systems is chilled water. The University has regional utility plants and some small localized central chilled water plants that support several buildings. For new construction and renovation projects, the Consultant shall verify that the existing chilled water system will support the new load. Verification may require that the designer perform a detailed building audit to identify all building loads if this information is not readily available.

B. Renovations to existing chillers and towers shall require careful and realistic scheduling in order to minimize the impact on building users.

C. The Designer shall consider using a Water Side Economizer to meet winter cooling loads in applications where the use of 100 percent outdoor air for free cooling is not possible. Plate & frame heat exchangers are strongly recommended for this application.

D. Use of a side stream filter is strongly recommended for the cooling tower side of the system. It is essential that the Designer provide means to service the heat exchanger without lengthy system shutdown.

E. Marine water boxes shall be considered on all chillers 500 ton and larger.

2.5 BOILERS

A. If connecting to either the Steam Plant steam distribution system or the Regional Utility Plants hot water system is not feasible, individual boilers may be considered. Where individual boilers are required,
   1. Gas fired, forced draft boilers will be utilized.
   2. Electric boilers are not acceptable.
   3. Temperature reset controls will be utilized on hot water systems.
   4. Boiler capacities will be limited to a maximum of 10 million Btu/hr INPUT where oil is used as the fuel.

B. **Boiler gas vents / chimneys are expected to be terminated above roof**. Any exceptions will have to be verified with University's Facilities Mechanical Engineer before incorporating into design.

C. When Fire Tube Hot Water Boilers are used they will be scotch marine wet back boilers.
   1. Gas fired burner will have minimum 8:1 turn down ratio. System will maintain fuel-air ratio automatically with gas temperature minimum 68 F above dew point of flue gases at boiler outlet. The burner will be low NOx burner.
   2. Combustion control: Parallel positioning type system with microprocessor controlled fuel air ratio. System to utilize linkage-less type direct servomotor control of each fuel control valve, combustion air damper and recirculation stack gas flow damper (if required). Servomotors to have repeatability accuracy of 0.1% of an angular degree and system to have a cross-limiting function for safety. System to accept 4-20mA, 0-5dcV or a digital signal from modulating temperature controller and/or an external firing rate control interface from the facility BAS.
   3. Flame safeguard system (FSG): Microprocessor based burner management control with UV flame scanner system, Modbus module and expanded annunciator. The Modbus module will allow burner control's interface with building BAS. Expanded annuciator will interpret the error codes to indicate the faults. All available system limits and applicable operation functions to be factory wired to FSG system for monitoring/annunciation (low water, no water flow, fuel pressure switch, high water temperature, pressure, etc.)

Furnish window in control panel, or a remote display module in the main panel to view FSG status.

4. Provide remote start-stop relay and all components wired to panel terminal strip.
5. Provide permanently mounted and wired (6) digit non-reset elapsed time (hour) meter installed in main burner panel to initiate during active boiler use.
6. Integrate combustion and FSG to BAS.

2.6 REFRIGERATION EQUIPMENT

A. Preference shall be given to chilled water production based on water-cooled centrifugal chillers. Other options may be considered if circumstances warrant and are approved by the Owner.

B. Generally, the Designer shall select water-cooled reciprocating or rotary chillers for cooling loads up to 100 tons. For cooling loads over 100 tons shall be screw or centrifugal. Loads requiring high turn down shall be specified as magnetic bearing chillers.

C. Air-cooled equipment shall be used for small renovation projects where physical limitations preclude the use of chilled water. Selection shall be based on 105º F ambient temperature.

D. For water cooled machine, provide head pressure control for cold start up of the machine in lieu of cooling tower bypass.

E. Manufacturer shall provide a Modbus, BacNet over Ethernet or LonWorks interface to the controls Building Automation System (BAS). Data available to the BAS must include all chiller data read on microcomputer control center, (on, off) commands and status, set points, and alarms. Integration of data to the BAS is the responsibility of the Control Systems Integrator.

F. The Consultant shall specify chillers that utilize environmentally safe refrigerants that conform to the latest Environmental Protection Agency and OSHA requirements. Mixing of refrigerants within the same mechanical room is discouraged.

G. Ventilation of all mechanical rooms with refrigeration equipment shall be provided. Ventilation shall be accessible for activation from an emergency switch in a protected enclosure located outside any of the mechanical room access doors. Mechanical room ventilation shall be negative to corridor or any other adjacent spaces. Ventilation and room design shall comply with the latest version of ASHRAE Standard 15. SCBA will not be installed.

H. Provide refrigerant sensing devices according to latest ASHRAE standards. Tie the alarm output to the building DDC.

I. Special attention shall be paid to evaluation of chiller noise levels. If necessary acoustical enclosure for the chiller compressor and accessories may be specified to maintain noise levels in mechanical room within acceptable level. Oil-less magnetic bearing chillers are recommended for chillers installed within the occupied building.

J. Witness test. The Owner reserves the right to require a witness test of the machine purchased. The Owner and a representative of the Owner's choosing will, at no additional cost to the Owner or the Owner's representative, witness an eight hour test run of the purchased machine at the manufacturing facilities of the successful vendor. It shall be the manufacturer's responsibility to advise the Owner ten days in advance of the test date so travel arrangements can be made.

2.7 PUMPS

A. Chilled water plants are designed with primary and secondary pumping systems. To increase overall building system reliability, each pumping system shall be specified with parallel pump operation sized for 125% of design flow. Consideration shall be given to primary variable volume systems.

B. Since pumps use considerable amounts of energy, it is of prime importance to select pumps with the highest efficiency available for the particular application. The designer shall evaluate the wire-to-water efficiency before the final selection is made.

C. To prevent waste of energy in hydronic systems, three-way or bypass valves shall not be used except for “end of line” application. Use of variable frequency drives for pumps is recommended. If multiple pumps are to be used in parallel, pump VFD controller is recommended to be included as part of the VFD package. Manufacturers recommended for such application are ITT B & G, Armstrong, Systecon and Synchroflow.

D. Manufacturer of VFD package shall provide a Modbus RTU, BacNet over Ethernet/MSTP or LonWorks interface to the controls Building Automation System (BAS). Data available to the BAS must include all chiller data read on microcomputer control center, (on, off) commands and status, set points, and alarms. Integration of data to the BAS is the responsibility of the Control Systems Integrator.

E. Pumps shall be installed in mechanical equipment rooms. Outdoor pump installation shall be avoided.

2.8 AIR TERMINAL UNITS

A. Air terminal units located above ceiling shall be located no more than 2’ above ceiling for access for maintenance.

B. Use of fan terminal units must be pre-approved by Facilities’ Mechanical Engineer. If approved, the units and associated filters must be within 2’ above ceiling to allow easy reach by campus maintenance.

SECTION 23 7000 - AIR DISTRIBUTION

PART 1 - GENERAL

PART 2 - PRODUCTS

2.1 DUCTWORK

A. Ductwork for air distribution shall be designed to yield minimum owning and operating costs by keeping the static and dynamic pressure levels of a duct as low as possible given the building's normal physical constraints

B. Ductwork shall be free of excessive sound levels. Duct air leakage will not exceed 2 to 5 percent.

C. To allow for proper system balancing, all branch ducts shall be equipped with balancing dampers.

D. Air-measuring stations shall be provided for variable-volume systems using variable-frequency drives.

E. Ductwork fabrication and installation shall follow the latest recommendation of SMACNA.

F. The use of flexible ductwork shall be avoided. The maximum length of a flexible duct shall not exceed 5'. Avoid offsets and curves in flexible duct connections to diffusers and other terminal devices.

G. Provide hard elbows at turn down to diffuser connections.

H. Provide sound attenuation elbows on private office return grilles.

I. Provide access doors large enough to allow service and inspection of control dampers, reheat coils, humidifiers, fire dampers, and all applicable system components. An access door size of 24” x 24” is recommended.