PLUMBING AND MECHANICAL SYSTEMS DESIGN GUIDELINES

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I. PLUMBING SYSTEMS

A. PLUMBING – GENERAL

Cleaning Domestic Water Lines of Debris With High Rate Flushing

After the plumbing work is completed, the domestic water system requires flushing of the lines for testing of system integrity. The following protocol should be outlined within the construction documents.

1. For all fixtures with aerators

Aerators have screens that reduce flow and trap debris. For devices with aerators, it is essential to remove the aerator before flushing.

With the Aerator removed, let the water run through the device for 10 minutes at the highest flow rate. If booster pumps are installed in the building, make sure that they are operating, to achieve the highest normal operating pressure during flushing that will occur in the buildings lifetime. This will achieve the highest normal possible velocity in the plumbing lines and maximum cleaning.

After flushing, clean the aerator by rinsing it with water before replacing it.

2. For all fixtures without aerators

Let the water run through the device for 10 minutes at the highest flow rate. If booster pumps are installed in the building, make sure that they are operating, to achieve the highest normal operating pressure during flushing that will occur in the building's lifetime. This will achieve the highest normal possible velocity in the plumbing lines and maximum cleaning.

3. Forming a Protective Layer on the Brass in the System

Turn on the cold water for all faucets in the building, such that some water flows out for 3 days at low flow. Any flow rate from 2 drips per second to a small "trickle" from each fixture is adequate. Very high flow rates should be avoided because they waste water and, if take to an extreme, might actually prevent formation of a protective layer.

4. Building Water System Flushing of All End Point Devices Used for Potable Water Intended for Human Consumption

a) Leave a message for the EHS Occupational and Environmental Hygiene Manager on phone (843-7313) when building flushing will begin. Identify the building and the site contact information in the message.
b) Leave a message at the same EHS phone when the flushing is complete.

Overflow Lines - Extend all equipment overflow or blowdown lines to a floor sink or floor drain connected to the sanitary sewer system.

Design water supply piping for human consumption so that food areas, breakroom sinks, and water fountains are not at the end of a plumbing run, and are located so that the water supply has a high rate of turn-over to assure high water quality.

The designer shall specify appropriate cleaning and disinfecting procedures for domestic water piping systems, compliant with AWWA and OWASA (below grade domestic water piping only).

Specify RPDA backflow preventers, on the domestic water main with accordance with OWASA guides.

B. PLUMBING FIXTURES

(NSF-61-5; California Prop. 65; Prop. 65 end point plumbing devises where used for human consumption)

1. Urinals

Specify 0.125 gpf fixtures.

2. Water Closets – NSP 61/ASME 61.9 Approved.

Specify low-flow or ultra low-flow water closets with manual rather than infrared flush. Dual-flush water closets encouraged. ADA facilities shall incorporate infrared flush.

3. Lavatories

Specify low-flow lavatories with faucet aerators with push timed or engaged drop stick metering.

4. Showers

Specify low-flow showers with single handle that enables off/on temperature maintenance.

5. Floor Drains

Floor drains, and other commonly used drainage facilities are typically installed in a standard manner throughout buildings without having a specific need or function. The installation of these devices creates a tremendous maintenance problem in maintaining trap seals. The design engineer shall carefully evaluate the need for all such devices and make sure there is a legitimate requirement for their installation. Installing devices in a generic fashion is not acceptable.

Provide floor drains which require removal of the cover with a "special tool" or by qualified people.

Floor sinks for exterior stairwells, if required, shall be a minimum of 4" with a 12" x 12" x 6" drain well with grate-type cover.

6. Water Coolers

Provide manufacturer recommended clearances. Provide ½" piping min. to water coolers to prevent bubbler height bounce with pressure fluctuation. Do not specify remote mounted condensing units. Condensing units should be accessible from the front of water cooler and in same enclosure.

Remote and stand alone water coolers will be installed with at least the minimum side, front, rear and floor air flow clearances that are recommended by the manufacture and will not be recessed into areas with poor air flow. The water supply shall not be tied into the same supply water that feeds the rest room fixtures to prevent bubbler height bounce when any flush valve is activated.

C. ELEVATOR SUMP PUMPS

Elevators shall be provided with sumps and sump pumps. Elevator sump pumps shall have an oil sensing shut-off, with alarm, and shall be piped to the sanitary sewer.

II. HEATING, VENTILATING and AIR-CONDITIONING

A. HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)

1. General Notes

Refer to the following for additional HVAC design requirements:

- Laboratory Design Guidelines.
- UNC Chapel Hill Controls Guidelines.
- UNC BSL3 Laboratory Guidelines.
- Energy Modeling Guidelines
- Solar Generation/Alternative Energy Guidelines
- Refer to "Building Systems" for general system descriptions and designer requirements.
- Refer to "Site Utilities" for information on UNC utilities.

2. Accessibility

All serviceable equipment (smoke dampers, fire dampers, control dampers, duct smoke detectors, fans, valves, coils, terminal units, pumps, filters, isolation valves, clean-outs, junctions, etc.) installed behind an inaccessible finished surface requires the installation of suitable access doors. It is the designer's responsibility to identify, in the contract documents, the minimum size of all access doors. Ensure that access to these doors is not blocked by conduit, wire trays, ductwork, etc.

3. Equipment Cleaning and Protection of Work

Specify all new and reused equipment installed under this scope of work to be completely cleaned to new condition (inside and outside). Specify any required maintenance on reused equipment to ensure it is 'like new'. Specify that cleaning solutions may not be discharged to the storm sewer system.

Spare parts are to be turned over to the owner and not left in the building mechanical rooms.

4. HVAC General Requirements when Operated During Construction

- Building must be fully enclosed, including installation of all doors, windows, etc.
- Set air handler to use 100% OA if construction is still generating dust and when conditions will not allow the coil to freeze.
- All chilled water piping shall be insulated.
- Laser alignment of pump shafts shall be completed and reports provided to the designer and also included in the O&M manuals.
- All connections of ductwork (supply and outside air) to AHU's shall be complete.
- All manual dampers, fire dampers and combination fire/smoke dampers shall be open.
- If return air is to be used then all exhaust and return ducts/grilles shall be covered with temporary filter media (at a minimum a double layered cheesecloth and all filters media - MERV 8 - required by LEED or other standards) to prevent dust infiltration into ductwork system.
- All main supply ductwork shall be insulated.
- All safety circuits and basic control functions shall be active and fully functional. The contractor is not allowed to operate equipment in the facility during unoccupied times without a fully functional and tested control system.
- Once the conditioning (cooling & dehumidifying) of the building is started, it should stay conditioned.

- Final approval of UNC is required prior to starting AHU's for temporary operation.
- Specify that outside air intakes are covered with 1" roll filter media. Filters should be removed prior to occupancy.
- Specify that the contractor perform all required preventative maintenance on mechanical equipment operated during construction. Require the contractor to provide documentation in the operation and maintenance manuals of preventative maintenance activities completed during this time.
- At the end of the construction period prior to occupancy clean the inside of AHU's and install new pre and final filters.

5. Performance Tests

Should the University or the Designer have any reasonable doubt as to the proper functioning of any equipment installed under this Contract, at any time during the guarantee period; the University and/or Designer has the right to perform any test deemed practical to determine whether such equipment is functioning properly and performing at specified capacity.

6. Training

The University views training requirements as two fold, (site specific) systems orientation and systems training. The designer shall specify that the contractor provide onsite orientation for representatives of Facilities Services. The duration shall generally not be less than two days and is required prior to building occupancy. The designer shall also specify additional classroom training for temperature control systems and for any system unique to the University. The designer shall coordinate through the UNC Construction Project Manager with UNC Facilities Services to determine the appropriate training required. This systems training shall be in an appropriate classroom setting and shall be performed by an authorized representative of the system or equipment, and shall be completed prior to project closeout. The designer should direct the contractor to submit training schedules, training syllabus, and resumes of the person(s) giving the training to the University for review and final approval.

B. ELECTRICAL REQUIREMENTS FOR MECHANICAL EQUIPMENT

Disconnecting means furnished integrally with equipment is considered adequate if the disconnecting means is properly sized and fused.

For starters located adjacent to the motor served then specify that combination starter type.

For all starters specify with integral control transformers, solid state thermal overload protection, 120 volt coils, low voltage protection, indicating pilot lights (neon or LED type), hand-off-automatic switches and all necessary auxiliary contacts. Starters shall be UL508 listed for the available short circuit current. All starters, including skid mounted starters, shall be NEMA rated. IEC rated starters are not acceptable.

UNC considers the division of work between Division 15 and Division 16 to be reflective of the policy under the N.C. State Construction Guidelines. This states that Division 15 is responsible for electric service for mechanical equipment from the electrical disconnect to the equipment. Division 16 is responsible for electrical service to the disconnect.

C. MOTORS

Indicate horsepower ratings for all motors on both Division 15 and Division 16 construction drawings.

Specify single phase protection for multiphase motors.

Specify that all motors conform to the latest IEEE or NEMA standards relating to characteristics, dimensions, tolerances, temperature rise, insulation, and ratings for noise and vibration.

Specify NEMA class F insulation with Class B temperature rise and 1.15 service factor in an ambient temperature of 40degC maximum. Bearings shall have an ANSI/AFBMA L-10 rating of 200,000 hours for direct connected service and shall be capable of being relubricated.

Specify 480V, three phase electrical service for motors 1/2 Hp and larger.

Specify motor casings to be fully cast iron on 3 horsepower motors and above.

Specify premium efficiency motors, as defined by NEMA MG-1, for all motors 1 Hp and larger.

Motors used with variable frequency drives must, at a minimum, meet the requirements of NEMA MG-1, part 31 "Definite Purpose Inverter-Fed Motors".

All motors shall be mounted on the same base as the rotating equipment they serve (for alignment purposes).

D. MECHANICAL VIBRATION AND SEISMIC CONTROL

All mechanical equipment with rotating, reciprocating or oscillating components shall be mounted on, or suspended from, vibration isolators to prevent transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflection and noise mitigation

Specify vibration isolator type and static deflection to allow a maximum of one percent vibration transmissibility to building structure at lower driving frequency for equipment.

E. MECHANICAL IDENTIFICATION

1. Equipment Identification

Specify that all major HVAC and plumbing equipment, including air handlers, fans and pumps is properly identified with equipment identification, equipment controlled, electrical ratings and date of installation. Equipment should be clearly identified with engraved phenolic plates securely fastened to the equipment with sheet metal screws. Specify phenolic plates with white background and black lettering. Specify that all serviceable equipment (fans, reheat coils, V.A.V. boxes, etc.) located in concealed spaces is clearly identified on an adjacent finished surface (location determined by the Designer).

2. Pipe Identification

Completely paint piping systems in mechanical rooms with the applicable colors listed below with appropriate self-sticking or strap-on identifications and arrows indicating direction of flow. Piping and ducts in chases above ceilings, etc. should be color banded and have stencil markings at appropriate intervals. On straight runs of piping, space marking no further than 30 feet apart; and with stencil identifications, color bands, and direction arrows near each valve, pressure reducing valve, heat exchanger, etc. Where pipe passes through walls or floors, mark near the penetration on both sides. Provide markings at each directional change of all piping systems. Mechanical room pipe color and the colors of bands are as follows:

Piping System	Color	Stencil Identification
Condensate Return	Light Brown	COND
Steam, High Pressure (25-75 psi)	Bright Red	HPS
Steam, Low Pressure (0-25 psi)	Dark Red	LPS #__
Water, Chilled, Supply	Marlin Blue	CWS
	Rustoleum 925	
Water, Chilled, Return	Marlin Blue	CWR
	Rustoleum 866	
Water, Cold Domestic	Dark Green	DOM CW
Water, Distilled	Slate Gray	DSTW
Water, Condenser, to Condensers	Fed. Safety Green	CC
Water, Hot Domestic	Red	DHW
Water, Hot Domestic, Recalculating	Orange	DHWR
Water, Hot, Heating	Light Gray	HWS
Gas	Black	GAS
Air	Dark Gray	AIR
Nitrogen	Pastel Gray	
Helium	Pastel Gray	
Hydrogen	Black	
Vacuum	Beige	VAC
Chemical	Yellow	
Sprinkler	Safety Red	SPKR
Fire Line	Safety Red	FIRE
Ductwork	Light Gray	

Pipe identification should contrast in color to the pipe colors and be easily readable. The width of color bands should be equal to the size of the stencil indicated below.

For insulated pipe systems, stencil sizes are as follows:

- For pipes up to 1 inch, use 1 inch letters.
- For pipes 1 inch to 2 inches, use 2 inch letters.
- For pipes 2 inches to 6 inches, use 3 inch letters.
- For pipes above 6 inches, use 4 inch letters.

For un-insulated systems, stencil sizes are as follows:

- For pipe diameters up to 1 inch, use 1/2 inch letters.
- For pipe diameters from 1 inch to 2 inches, use 1 inch letters.
- For pipe diameters from 2 inches to 6 inches, use 2 inch letters.
- For pipe diameters over 6 inches, use 3 inch letters.

3. Duct Identification

At each floor level and at roof level identify each exhaust air duct from safety cabinets and fume hoods by two-inch (2") tall painted black lettering identifying the room it originates from.

4. Valve Identification

The designer shall specify isolation and control valve identification utilizing brass valve tags with chains. Additionally specify a valve tag chart to be mounted under plexiglass in the main mechanical room and in the O&M manual. Further, include the tag numbers on 'as built' drawings.

F. MECHANICAL INSULATION

1. General

Specify insulation to provide an adequate thermal barrier well as protection from moisture condensation on exterior of pipe or duct whose surface temperature drops below ambient conditions. In all cases the designer should confirm the size and type of insulation specified is sufficient to prevent surface condensation.

Insulation applications requiring compliance with flame spread rating of 25 and a smoke developed rating of 50 shall be tested in accordance with ASTM-84 by Underwriter's Laboratories.

Specify insulation on all valves, flanges and elbows, tees and other fittings in insulated piping with the same type and minimum thickness of insulation on adjoining pipe.

Specify insulation which provides access to circuit setters, control valves, strainers, unions and flexible connections.

Specify continuous insulation across pipe hangers, air handler casings, sleeves and walls.

2. Piping

Specify corrugated aluminum jacketing or PVC jacketing on insulated piping in mechanical rooms from floor level to 8 ft. above finish floor.

a) Cold Plumbing Piping

- Insulate the following cold plumbing piping systems:
  - Domestic cold water piping.
  - Industrial cold water piping.
  - Interior roof drain leader and roof drain overflow piping to include the body of the roof drain and 10 ft. into the building shell, as a minimum.
- Insulate each piping system specified above with one of the following type:
  - Fiberglass.
  - Flexible Unicellular.

b) Hot Plumbing Piping

- Insulate the following hot plumbing piping systems:

- Domestic hot water piping.
- Industrial hot water piping.
- Domestic hot water recirculating piping.
- Industrial hot water recirculating piping.

- Insulate each piping system specified above with one of the following types:
  - Fiberglass
  - Flexible Unicellular.

Sub-Zero Piping

- Below 0 deg. F (-18 deg. C): Insulate low temperature refrigerant piping with one of the following types:
  - Flexible Unicellular.

c) Sub-Freezing Piping

- 0 to 39 deg. F (-18 to 4 deg. C): Insulate refrigerant suction lines between evaporators and compressors and brine refrigerant piping with one of the following types:
  - Flexible Unicellular.

d) Chilled Water Piping

- 40 deg. F (4.4 deg. C) to ambient:
  - Fiberglass: Not permitted.
  - Cellular Glass.
  - Closed cell foam.
  - Polyisocyanurate (nominal 2 lb./ft3).

e) Hot Low Pressure Piping

- Up to 250 deg. F (121 deg. C): Insulate the following hot low pressure HVAC piping systems (steam piping up to 15 psi, water piping up to 250 deg. F (121 deg. C).
  - Steam piping to 25 psi
  - HVAC hot water supply and return piping.
  - Heated fuel piping.
  - Hot gas refrigerant piping.
- Insulate each piping system specified above with one of the following types:
  - Fiberglass.
  - Calcium Silicate or Cellular Glass.

f) Hot Medium Pressure Piping

- Up to 305 deg. F (152 deg. C)
  - Steam piping from 26 to 75 psi.
- Insulate each piping system specified above with one of the following types:
  - Fiberglass.
  - Calcium Silicate or Cellular Glass.

g) Hot High Pressure Piping

- Up to 450 deg. F (232 deg. C):

  - Steam piping from 76 to 200 psi.
- Insulate each piping system specified above with one of the following types:
  - Fiberglass: Provide Class 13 for superheated steam over 450 deg. F (232 deg. C).
  - Calcium Silicate or Cellular Glass.

Specify that the Contractor replace calcium silicate which becomes wet during the construction period due to unfinished work.

h) Hydronic Equipment

- Insulation for devices on items requiring regular maintenance, such as steam traps, heating water devices, and chilled water devices should be easily removable.
- Insulate the following equipment items:
  - Heating water air separator.
  - Hot water converters.
  - Steam traps.

i) Ductwork

Lined duct is not permitted. Designer may consider and recommend on a case by case basis for specific applications such as theaters or performance halls where sound or other considerations apply

Specify rigid insulation for ductwork installed in mechanical rooms from floor level to 8 ft. AFF.

Externally insulate all exposed supply, return and outside air ducts with rigid fiberglass insulation. Ductwork installed in mechanical rooms shall be with 8 oz. canvas lagging, minimum.

Provide continuous insulation on supply duct at joints and throughout duct system from cooling coil to supply air grilles. Insulate all equipment including reheat coils, diffuser necks, fire dampers, and flexible connections.

- Insulate the following ductwork:
  - Outdoor air intake ductwork between air entrance and fan inlet or HVAC unit inlet.
  - HVAC supply ductwork between fan discharge, or HVAC unit discharge, and room terminal outlet.
  - Insulate neck and bells of supply diffusers.
  - HVAC return ductwork between room terminal inlet and return fan inlet, or HVAC unit inlet.
  - HVAC plenums and unit housings not pre-insulated at factory.
- Insulate each ductwork system specified above with one of the following
  - Rigid Fiberglass: 2" minimum thickness in machine, fan and equipment rooms.
  - Flexible Fiberglass
  - Cellular Glass
  - Flexible Unicellular

j) HVAC Equipment

- Insulate the following equipment:
  - Boilers (not pre-insulated at factory).
  - Hot water storage tanks.
  - Water heaters (not pre-insulated at factory).
  - Heating hot water converters

  - Heating water air separators.
- Insulate each item of equipment specified above with one of the following:
  - Fiberglass.
  - Calcium Silicate.
  - Flexible Unicellular: (Do not use for equipment operating above 180 deg. F (82 deg. C).)

G. VALVES

Combination balancing/shutoff valves shall be independent and using the shut off function should not affect the system balance when the valve is reopened.

Pressure independent flow balancing devices are not permitted.

Butterfly valves are not acceptable valves for flow balancing.

H. METERS AND GAUGES

Specify pressure/temperature test stations, combination (P/T plug) on supply and return piping of all air handling unit water coils not otherwise provided with pressure and temperature gages. The basis of design shall be Peterson Equipment Company (Pete's plug).

Water and steam pressure gauges shall be liquid filled.

Specify a single gauge with isolation valves when reading differential pressure across a piece of equipment.

Provide water totalizing meter and y-strainer for makeup water lines on hot water boilers, heating water systems, run around heat recovery systems, and other similar closed systems with makeup water lines.

I. HYDRONIC PIPING

The use of float type automatic air vents is not permitted.

Specify flushing and cleaning for piping systems before they are put in service. Do not utilize building pumps for circulating cleaning fluid to maintain design water velocities for the duration of the test.

J. PUMPS

1. General

- Mechanical schedules for circulation pumps shall indicate minimum pumping efficiencies.
- Provide a minimum clearance of 24" on sides and ends of base mounted pumps and motors to allow access for service and repair.
- Specify isolation valves allowing removal of pumps for repair.
- Specify the installation of bleed valves and gauge ports at accessible locations.
- All pumps shall be serviceable without removing the volute from piping connections.
- Specify that all pump mechanical seals shall have ceramic stationary seats.
- Specify a (single) pressure gage with isolation valves on base mounted pumps to provide suction pressure, discharge pressure, and differential pressure.

2. Pump-Motor Alignment for Flexible Coupled Pumps

Specify that the contractor employ a technician certified by the selected pump manufacturer to field align flexible coupled pumps after the base has been grouted and flushing and cleaning procedures are completed. Specify that pump and motor is aligned in all four planes: vertical angular, horizontal angular, vertical parallel and horizontal parallel. Alignment shall be within the recommended value by pump manufacturer (not coupler manufacturer) but not over 0.002" parallel and 0.005" angular per radius-inch. Specify that the contractor record and submit all results of alignment procedure and the pump manufacturer's alignment specifications to the design engineer. The specifications should also require this approved submittal information is included in the O&M Manual.

K. STEAM AND STEAM CONDENSATE PIPING AND CONDENSATE PUMPS

- This section covers steam piping downstream of the building pressure reducing valve.
- Locate steam traps for mechanical equipment a minimum of 12 inches below the device being served.
- Specify minimum schedule 80 piping for steam and condensate piping 2 inches and smaller.
- Specify steam piping (and associated devices) within the building envelope compliant with ASME Standard B31.1 Power Piping.

L. BOILERS

- Specify IRI gas trains on all boilers.
- Condensing boilers are not permitted.
- Specify boiler controls to provide heating hot water year around.

M. HVAC SYSTEMSS

1. General Requirements

Location of Air Intakes: The location of air intakes should be remote from sources of pollutants and the building air intake and exhaust outlets shall be remotely located from each other to prevent supply air contamination. Intakes should be located so moisture or odors from landscape materials is not introduced into the air stream. Take special care to ensure that exhaust from hoods, emergency generators, etc., is not pulled into the building through make-up or fresh air intakes. Install hardware cloth, size 2 mesh, inside the louver to eliminate leaves, debris, etc. from lodging behind louvers. Paint the hardware cloth the same color as the louvers.

The designer shall provide indication in the construction documents of areas with critical relative pressurization requirements, such as laboratories. The designer shall designate the pressure differential in CFM or static pressure and require the TAB contractor to balance these zones to the pressurization specified.

Sound Attenuation. Incorporate necessary attenuation strategies to minimize noise in occupied spaces. ASHRAE's noise guidelines are considered to be the maximum acceptable noise levels.

Building HVAC systems must be able to operate under the established requirements of the centralized chilled water, steam, and heating hot water systems.

2. Condensate Drain Lines

- Provide clean-outs at proper locations, and slope drain lines correctly to assure good drainage.
- Each drain shall be trapped to provide no air leakage at unit and provide complete drainage of unit. The drain lines shall be 1" dia. minimum. Materials of construction shall be Copper.
- Do not route condensate drain lines to storm sewer system or to building exterior.

N. AIR HANDLING UNITS (PACKAGED AND BUILT-UP)

1. General

- Guidelines for components listed under this section are applicable to relative sections.
- Specify an auxiliary drain pan under the entire air handler when it's installed over occupied spaces.
- Specify ultraviolet (UV) lights for chilled water coil protection.
- Specify that all air handling units have an IAQ package, including stainless steel pitched and triple sloped drain pans and support framework in the cooling coil section.
- Specify solid double walled construction with internal vibration isolation.
- Specify aluminum grating over all drain pan sections.

Do not install units above ceilings. Where this is unavoidable, or where units are installed in other concealed locations, provide auxiliary drain pans in addition to drain pans provided with the unit. Provide capped drain plug on pan. Provide water detection system(s) in auxiliary pan which shuts unit down and closes the chilled water valve to the coil on detection of water. Do not install auxiliary drain pans in a manner which interferes with service access to the unit. Do not locate units above rigid type ceiling that would require dismantling of ceiling for access to the unit.

Specify base rail heights for draw through units 3" greater than twice the maximum fan suction pressure. For blow through units specify the minimum base rail height 3" greater than the max fan discharge pressure.

Specify (differential) pressure gauge(s) across each section of the air handler, including, but not limited to: across supply and return fans, across each filter section, and across each coil. Specify that the gauge(s) are installed to provide static pressure and/or differential pressure for each section of the air handler. Pressure gages shall be sized to provide measurement in 1/10 in. W.G. increments or less. Calculated operating point shall be at 50% of full range. Mount pressure gauge(s) to exterior of air handler. Specify copper tubing.

Specify air handling units to withstand 8" w.g. positive or negative internal pressure, or the fan shut off pressure whichever is greater. Leakage shall be one half of 1% of design airflow at 1.25 times operating static pressure.

Units shall be specified to require external connection to all coils, drains, electrical, controls, and ducts. All piping connections shall extend 3" through the panel casing and terminate with either flanges or threaded connections as applicable.

Removable panels shall be installed and located to facilitate removal of major components such as coils, fans and motors.

All pipe and conduit penetrations shall be sealed air tight. After wire is pulled conduit shall be sealed so that air cannot be transferred into or out of the unit.

Major components shall be supported from the unit framework, not the casing.

Wall and roof casing shall be double wall, insulated sandwich panel construction. Outer wall shall be at minimum 0.040" Aluminum, 22 gauge 304 SS, or 22 gauge galvanized steel. Inner walls shall be .040" aluminum, 22 gauge 304 stainless steel or 22 gauge galvanized steel. Insulation shall be 2" polyurethane for walls, floors, and roof having a "U" factor of no more than .066. Fiberglass insulation and insulation utilizing CFC or HCFC blowing agents is not permitted. The floor shall be 3/16" checker plate aluminum or steel.

All panel connections shall use aluminum extrusions with a phenolic resin thermal break for no through metal construction. Intersecting extrusions shall be continuously welded to form an airtight seal.

Access doors shall be sized to provide walk-in access to each section. Doors shall be wide enough to remove replaceable unit components. Door construction shall match unit casing. Doors shall be perimeter, airtight, double sealing with replaceable ¾" x 5/16" neoprene gaskets. All doors shall be installed to open against the greater air pressure. Minimum door size shall be 24" W x 60" H unless unit height limits the door height. Provide test ports in all doors.

- Specify view panels for all walk in units.
- Specify floor drains in all non drain pan sections.
- Specify pre-wired lights in each section for all walk in units. All 120V items shall be wired to a junction box.

Removable access panels, located at each coil and fan shall be provided to facilitate removal of each coil and fan. Panels shall be constructed the same as access doors and screwed in place on 6" centers. Access panels should facilitate cleaning of coil tubes from exterior of unit without shutting down the unit when removable header coils are specified.

Extend bearing grease lines to an accessible location at the exterior of the air handler. Specify minimum fan bearing life of L10 200,000 hours.

2. Leakage testing for larger units (>40,000 cfm):

Specify that all units are to be factory and field tested for a maximum of 1% of design cfm allowable leakage at 10" positive and 10" negative pressure. All units will be factory and field tested for deflection based 1/200 of the greatest span at 12" positive and 12" negative pressure. The owner has the option to witness all testing. The unit supplier shall reimburse the owner for all travel expenses (1 person). All testing will be performed by the unit supplier. The designer should discuss this section through the UNC Design Project Manager with a UNC Facilities Services Representative during design.

3. Heat Transfer Coils

- General Requirements
  - Air handlers providing ventilation air shall be designed with a preheat coil, regardless of outside air percentage or the calculated mixed air temperature.
  - Specify that coils shall completely fill unit casing. Do not overlap coils.
  - Specify electro-fin coating on the coils.
  - Specify continuous thickness, minimum 0.035 inches, including return bends.
  - Specify leak testing at 315 psig minimum.
  - Spray Coil Systems: Not permitted.
  - Specify for maximum air velocity not to exceed 500 feet per minute.
- Chilled Water Coils (requirements in addition to General Requirements)

- Refer to UNC Chilled Water Design Guidelines for supply and return water temperature requirements.
- Mechanical schedules for cooling coils shall indicate chilled water velocity in the coil tubes at design conditions.
- Specify stainless steel frames and stainless steel intermediate troughs.
- Specify for maximum air velocity not to exceed 450 feet per minute.
- Size coils for a maximum of eight rows at 10 FPI.
- Specify coils with water velocity between 4 and 6 feet per second at full load (design) conditions.
- Specify copper tubes with minimum thickness of 0.035 inches and aluminum fins with minimum thickness of 0.0095 inches.
- Specify 16 gauge stainless steel drain pans and stainless steel intermediate troughs. Cross break pan to drain connection. Drain pans shall be sloped and pitched to allow proper drainage.

4. Fan Selections

- Buildings serving administrative and classroom functions:
  - Specify fan construction class suitable for design airflow plus 20%.
- Buildings serving laboratories, research, health care functions:
  - Fan construction class shall be specified design airflow plus 30%.
- Belt Driven Fans
  - All belt driven fans shall have a minimum shaft size of 1-1/8". Each fan shall have means to relubricate the fan shaft bearings. Where necessary, extend grease fittings to an accessible location. Fans shall be checked for balance at all speeds and specified not to exceed manufacture's recommended vibration levels. Each fan shall have the sheaves aligned by contractor prior to acceptance by University. A spare set of belts for each belt driven fan shall be turned over to University at the end of project. All fans shall have a NEMA rated adjustable motor base for belt tensioning.

5. Motors

Specify that AHU manufacturer provide an integral rail and hoist for air handler motors twenty horsepower and larger.

Belt Drive Motors: Specify adjustable motor mounting bases. Align pulleys and install belts. Drives shall be flat synchronous belt drive system and belts shall be Goodyear Eagle PD or approved equal. THIS DRIVE SYSTEM SHOULD ONLY BE INSTALLED WITH A VARIABLE FREQUENCY DRIVE.

6. Filters

The designer shall specify that the Contractor furnish three (3) sets of filters (prefilters and final filters) for all air handling units prior to any testing or start-up of systems; with one set installed prior to start-up of systems; one set installed prior to acceptance of the building and subsequent to testing and balancing; and one set delivered to the University.

Specify the filter section access door on the upstream side of the filters.

7. Dampers

Control dampers shall be opposed blade type. Prototypical opposed blade dampers shall be Ruskin-CD50 series or approved equal.

8. Flexible Connections

Specify flexible connections for a minimum 10" wide x 1/16" thick and suitable for duct pressure up to 10" w.g.

9. Field Service and Equipment Startup

Specify a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections prior to unit startup. Specify a factory-authorized service representative to perform startup service.

O. HUMIDIFIERS

- Active humidification will usually be required to meet the winter indoor design requirements of 40% RH minimum. See controls sequences. Utilize campus steam, where available, for direct injection humidification.
- Duct mounted humidifiers are preferred for applications in variable volume systems.
- For duct mounted humidifiers, specify welded stainless steel ductwork from the humidifier downstream for a distance of 1.5 times the absorption distance of the humidifier.
- Specify a trapped drain for the stainless steel portion of the ductwork.
- Specify a humidity sensor downstream of the humidifier to alarm upon detection of high humidity and disable the humidifier. Differential pressures switches are not allowed as the only safety for the humidifier.

P. FAN-COIL UNITS

Fan coil units and blower coils are only permitted serving unoccupied spaces. Fan coil units shall have filter rack on the unit and not in the filter grid of the ceiling. Provide access for service of unit and filter change with no piping or fixtures located beneath unit or at access panels.

Q. DUCTWORK

- All ductwork shall conform to SMACNA HVAC duct construction standards, metal and flexible, latest edition.
- Internally lined duct is not permitted.
- Specify the use of low loss duct fittings. The contractor may use high static loss fittings only in cases where the space prohibits the use of low loss fittings.
- Ductboard is not permitted.
- Metal ductwork shall be sealed as required to pass the leakage test defined in specification section covering Testing, Adjusting and Balancing. In no case shall the ductwork sealant be less than SMACNA Seal Class B.
- Flexible duct connections to grille necks is not acceptable. Specify a 90 degree boot for flexible duct connections to grilles, registers and diffusers.

R. DUCT ACCESSORIES

Splitter dampers are not allowed for use as volume dampers.

Fire Dampers – Comply with NFPA 90A, 4.3.4 'Air Duct Access and Inspection'. In addition require the contractor to provide a minimum 144 sq. inches of access to the damper on ductwork larger than 14" on one side. On smaller ductwork specify a 2 ft. long removable section of duct for access.

S. VAV TERMINAL UNITS

VAV terminal units shall be ARI certified. The unit casing shall be a minimum of 20 gauge galvanized steel. The damper shall be heavy gauge steel with solid metal shaft rotating in Delrin or bronze Oilite self-lubricating bearing. Unit shall be factory leak tested and sealed noting such.

Fan powered VAV terminal units are allowed only with written approval from the University. The approval request shall include the location of each unit for service.

T. AIR FILTERS

Provide 3-ply synthetic media type pre-filters with internal wire frame with viscocine between the second and third layers with a minimum ASHRAE efficiency of 20% and arrestance minimum of 85%.

On side access units join these filters in a sausage link manner to discourage by-pass air.

All units shall utilize bag filters or rigid box filters of the synthetic media type with gaskets applied to the filter for ease of replacement at each change.

1. Efficiency

In classroom and office environment, efficiency shall be a minimum of 60-65% according to ASHRAE standards.

In research and medical environments, specify 90-95% efficient bag filters.

Small package units may utilize 2 inch and 4 inch pleated filters as deemed necessary for unit sizing.

Specify units with industry standard size filter racks and approach velocities through filters at 500 fpm maximum.

U. BUILDING LEVEL TEMPERATURE CONTROL SYSTEM

The building automation system is a Lon based, open protocol system. The specifications are prescriptive in nature and changes to the diagrams or specifications must be pre-approved. The BAS will be a stand alone system, capable of operating the building by itself. The University requires the BAS to be connected to a central location called the Energy Management Control System located at the Giles F. Horney building. The 'EMCS" is responsible for BAS front end functions such as graphics, data trending, scheduling, etc. The EMCS 'integration' is performed through the project by UNC Facilities Services, and is funded by a project reserve. The BAS contractor will not manage this scope of work. The designer is responsible for editing and incorporating the sequence of operations and control drawings, BAS contract specifications and assisting with setting the reserve for the integration.

Refer to UNC Chapel Hill Controls Guidelines for more information.

V. TESTING, ADJUSTING AND BALANCING

1. Air and Water Balance

The designer shall specify that balancing be done by an Associated Air Balance Council Certified (AABC), or National Environmental Balancing Bureau (NEBB) balance specialist using skilled personnel who have training and experience in balancing air and water distribution systems. Specify the testing of all duct and fire dampers. Testing and balancing of air systems is performed in complete accordance with AABC National Standards for Total System Balance, 4th. Edition 1982, as published by the Associated Air Balance Council. Specify that balance reports are sealed by a licensed mechanical engineer in the State of North Carolina. A representative of the designer shall be present during testing.

2. Ductwork Leakage Test

Specify that all high and medium pressure ductwork is tested for air leakage. Testing should be completed before the installation of duct insulation. If duct is insulated before leakage testing is completed and leaks are found, it shall be the responsibility of the contractor to remove insulation from the entire section of the leaking duct, repair the leaks and replace the insulation.

Perform the following field tests and inspections according to SMACNA's "HVAC Air Duct Leakage Test Manual" and prepare test reports:

Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If pressure classes are not indicated, then specify the entire system is tested at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. Provide the university and the designer seven days' advance notice for testing.

Maximum Allowable Leakage: Maximum leakage shall be 1% of total cfm delivered by the air moving device(s).

Remake leaking joints and retest at contractor’s expense until leakage is equal to or less than maximum allowable.

3. Hot and Chilled Water Pipe Testing

Specify pressure testing of all new and reused hot and chilled water piping.