

307.4 Outline Specification Example - HVAC

Division 230000

1.1 CODES AND STANDARDS

A. Codes

1. The Kentucky Building Code (KBC)
2. Applicable Local Codes and Ordinances
3. National Electrical Code (NEC)
4. Occupational Safety and Health Administration (OSHA)

B. Standards

1. Air Conditioning and Refrigeration Institute (ARI)
2. Air Diffusion Council (ADC)
3. Air Movement and Control Association, Inc. (AMCA)
4. American National Standards Institute (ANSI) Laboratory Ventilation
5. American Society of Heating, Refrigeration and Air Conditioning Engineers (Handbooks, 62-73 Standard, 52-76 Standard and 90-80 Standard (ASHRAE)
6. American Society of Mechanical Engineers (ASME)
7. American Society for Testing and Materials (ASTM)
8. American Water Works Association (AWWA)
Institute of Boiler and Radiator Manufacturers (IBR)
9. National Electrical Manufacturers Association (NEMA)
10. National Fire Protection Association (NFPA)
11. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA)
12. Underwriters' Laboratories (UL)

1.2 DESIGN CRITERIA

A. Outside Conditions

- | | | |
|----|---------------------------------------|-----------------------------------------------------------------|
| 1. | <u>Heating</u>
6 ^o F DB | <u>Cooling</u>
93 ^o F DB and 77 ^o F WB |
|----|---------------------------------------|-----------------------------------------------------------------|

B. Room Conditions

- | | | | |
|----|--------------------|------------------------------|---------------------------------|
| | | <u>Heating</u> | <u>Cooling</u> |
| 1. | Gross Anatomy Labs | 65 ^o F and 30% RH | 65 ^o F DB and 57% RH |
| 2. | Other Areas | 70 ^o F and 30% RH | 75 ^o F DB and 50% RH |

C. Chilled Water Design Temperatures

- | | | |
|----|--------|-------------------|
| 1. | Supply | 42 ^o F |
| 2. | Return | 58 ^o F |

D. Hot Water Heating Design Temperatures

- | | | |
|----|--------|-------|
| 1. | Supply | 180°F |
| 2. | Return | 140°F |

E. Duct Friction Loss Sizing Criteria

- | | | |
|----|--------------------------|----------------------------------------|
| 1. | Low pressure ductwork | 0.06 inch W.G. max/100 equiv. feet run |
| 2. | Medium pressure ductwork | 0.03 inch W.G. max/100 equiv. feet run |

F. Duct Velocity Criteria

- | | | |
|----|--------------------------|------------------|
| 1. | Low pressure ductwork | 1200 FPM maximum |
| 2. | Medium pressure ductwork | 2500 FPM maximum |

G. Hydronic Piping Design Criteria - Copper Pipe

	<u>Pipe Size</u>	<u>Max. GPM</u>
1.	3/4"	3
2.	1"	8
3.	1-1/4"	13
4.	1-1/2"	21
5.	2"	45

H. Hydronic Piping Design Criteria - Black Steel Pipe - 8.0 FPS Max. Velocity

	<u>Pipe Size</u>	<u>Max. GPM</u>	<u>Max ΔP-Ft Water</u>
1.	3/4"	3	3.2
2.	1"	8	4.5
3.	1-1/4"	13	4.5
4.	1-1/2"	21	4.5
5.	2"	45	4.5
6.	2-1/2"	80	4.5
7.	3"	140	4.5
8.	4"	290	4.5
9.	5"	520	4.5
10.	6"	750	3.5
11.	8"	1,200	2.2
12.	10"	2,000	1.9
13.	12"	2,800	1.5

I. Low Pressure Steam Piping 10 PSIG and below Design Criteria - Black Steel Pipe
12,000 FPM Max. Velocity

	<u>Pipe Size</u>	<u>Max. #/Hr</u>
1.	1"	90

2.	1-1/4"	170
3.	1-1/2"	320
4.	2"	600
5.	2-1/2"	900
6.	3"	1,700
7.	4"	3,200
8.	5"	6,000
9.	6"	9,000
10.	8"	17,00
11.	10"	25,00

J. High Pressure Steam Piping 100 PSIG and Above Design Criteria - Black Steel Pipe -12,000 FPM Max. Velocity

	<u>Pipe Size</u>	<u>Max. #/Hr</u>
1.	1"	270
2.	1-1/4"	600
3.	1-1/2"	900
4.	2"	1,800
5.	2-1/2"	2,800
6.	3"	4,800
7.	4"	9,000
8.	5"	16,00
9.	6"	26,00
10.	8"	57,00

K. Condensate Return Piping Design Criteria

1. Minimum size: 1 inch.
2. Above 1 inch size: One size smaller than steam supply piping.

L. Condensate Pump Discharge Piping Design Criteria

1. Same as for Hydronic Piping Design Criteria

1.3 HVAC SYSTEMS - GENERAL

- A. Building is to be designed to achieve LEED Silver certification.
- B. High pressure steam will be obtained from the existing high pressure steam main in Building 55A equipment room.
- C. Provide a two-stage pressure reducing station in the basement mechanical room from 125 PSI to 50 PSI to 10 PSI to serve clean steam generator, domestic water heaters and heat exchangers.
- D. Space heating system for the building shall consist of dual steam to hot water heat exchangers, pumps and associated piping and controls located in the basement mechanical room. Heating water shall be distributed to reheat coils and supplemental units for entries, stairwells, etc.
- E. A clean steam generator, using softened water, and powered by high pressure

steam, will provide humidification for the air handling systems.

F. Provide a condensate return unit, duplex type, in basement mechanical room. Pumped condensate piping will be extended from Building 55A mechanical room to the new building.

G. Central Chilled Water System:

1. Chilled water will be obtained from the existing 18" chilled water piping in Building 55A equipment room.
2. A new chilled water variable speed pumping system will be provided and distribution within the building will be made to each air handling system.

H. Secondary Heating Systems:

1. Horizontal, vertical, or cabinet type hot water unit heaters with controls will be provided at mechanical and elevator equipment rooms, entrances, exits, and other areas as required.

I. Split system direct expansion fan coil and condensing units will be provided in the stairwells and elevator machine rooms.

J. Individual room temperature control will be provided, with a separate VAV air terminal unit and heating coil for each space.

K. Gross Anatomy air handling units will be 100% outside air and will be located in Penthouse Equipment Room.

L. Other air handling units will be return/outside air type and will be located in Penthouse Equipment Room.

M. Gross Anatomy Lab Energy recovery units will be located in Penthouse Equipment Room.

N. The Gross Anatomy Rooms will be exhausted by Strobic Air exhaust fans, arranged to have a redundant fan. Exhaust air will be discharged vertically at 3,000 FPM from stack above penthouse roof.

1.4 CENTRAL AIR HANDLING SYSTEMS-100% OUTSIDE AIR SYSTEMS

A. Systems will be constant volume systems. Fans will have variable frequency drives to compensate for filter loading.

B. Systems operating at 3.5 inches static pressure or less are low pressure units. Systems operating at higher than 3.5 inches static pressure are medium pressure units.

C. Each air handling unit shall comprise the following components:

1. Intake air plenum.
2. MERV 8 pre-filters
3. Preheat coil
4. Steam humidifier, Dispersion grid type.
5. Access sections.
6. Cooling coils with stainless steel drain pans and moisture eliminators.
7. Heating coil.
8. Draw thru supply fans with variable frequency drives and high efficiency motors.
9. Air distribution plate.
10. Sound attenuators.
11. MERV 14 final filters.
12. Supply air plenum.

1.5 CENTRAL AIR HANDLING SYSTEMS - OTHER AREAS

- A. Air handling units will be outside air/return air type and will be located in Penthouse Equipment Room. Outside air amounts will be determined by ASHRAE 62.1 Ventilation Code.
- B. Systems will be variable volume systems.
- C. Systems operating at 3.5 inches static pressure or less are low pressure units. Systems operating at higher than 3.5 inches static pressure are medium pressure units.
- D. Each air handling unit shall include the following components:
 1. Return air inlet plenum.
 2. Return fans with variable frequency drives and high efficiency motors.
 3. Return air-exhaust relief air chamber.
 4. Return air-outside air mixing chamber.
 5. MERV 8 pre-filters.
 6. Air blender section.
 7. Preheat coil.
 8. Steam humidifier, Dispersion grid type.
 9. Heating coil (single zone systems only)
 10. Access sections.
 11. Cooling coils with stainless steel drain pans and moisture eliminators.
 12. Draw thru supply fans with variable frequency drives and high efficiency motors.
 13. Air distribution plate.
 14. Sound traps.
 15. MERV 14 final filters.
 16. Supply air discharge plenum.

1.6 ENERGY RECOVERY UNITS

- A. Units will be the modular type.
- B. Systems will be constant volume systems.

C. Each energy recovery unit will include the following components:

1. Outside air inlet plenum.
2. Outside air filter.
3. Outside air discharge plenum.
4. Exhaust air inlet plenum.
5. Exhaust air filter.
6. Exhaust air discharge plenum.
7. Enthalpy wheel.

1.7 BUILDING EXHAUST SYSTEMS:

A. Exhaust systems will be provided for public toilets, janitor's closets, typical floor electrical closets, etc., as required.

1.8 DUCT DISTRIBUTION SYSTEMS:

- A. Medium pressure ductwork construction shall be based on ASHRAE medium 6 inches pressure type. Medium pressure duct construction will be used for supply ductwork upstream of the air terminal units.
- B. Supply air ductwork downstream terminal units, will be constructed for low pressure one (1) inch static pressure.
- C. Return and exhaust ductwork will be constructed for low pressure three (3) inches static pressure.
- D. 1 inch thick rigid board or 1-1/2 inch thick blanket glass fiber insulation, with vapor barrier, will be provided for air conditioning supply and outside air ducts.
- E. Exterior and interior space heating and cooling will be provided by variable air volume terminal boxes with hot water reheat coils served upstream by medium pressure duct mains.
- F. A 4'-0" maximum, insulated flexible duct will be provided to each air supply outlet.
- G. Sound traps will be provided at outlet of each air terminal unit for acoustical control.
- H. Tapered spin-in fitting, with lock-in quadrant and volume damper, will be provided from all branches to diffusers for low pressure ductwork.
- I. Fire and smoke dampers will be provided per Code requirements.
- J. Volume dampers will be provided for air balance purposes
- K. Install duct smoke detectors for air handlers per code requirements (refer to Electrical Section).
- L. Ductwork Cleaning:
 1. All ductwork will be cleaned and cleared of debris, dirt, etc.

M. Air Balance:

1. All air handling systems will be balanced for specified design flow rate and system static pressure, including submitting air balance reports by AABC certified air balance company.

1.9 PIPING DISTRIBUTION SYSTEMS:

A. Chilled Water System:

1. System pressure will be 200 PSI WOG maximum.
2. Gauges, thermometers, gauge cocks, thermometer wells, shut-off valves, balancing valves and other instruments will be provided for each piece of equipment for operation, maintenance and balancing purposes. Pete's (pressure and temperature) plugs will be provided at each cooling coil.
3. Pumping system will be a single primary loop with variable primary chilled water flow at each air handling unit.
4. Chilled water will be distributed to all air handling units.
5. Water flow balancing devices will be provided at individual return mains and the return branch of each floor.

B. Heating Hot Water System:

1. Heating hot water systems will be provided for reheat and preheat coils and unit heaters, including dual, steam-hot-water converters, steam pressure reducing valves, steam relief valves and vents, steam control valves, hot water circulating pumps, piping, valves, flanged opening for temporary start-up conical screen filtering assembly, "Y" type strainers at each pump suction, and control valve, expansion loops, anchors, air separators, expansion tanks, unit heaters, heating coils, bypass type pot feeders, controls, etc.
2. Gauges, thermometers, gauge cocks, thermometer wells, shutoff valves, balancing valves and other instruments will be provided for each piece of equipment for operation, maintenance and balancing purposes. Pete's (pressure and temperature) plugs will be provided at each heating coil.
3. Guides, anchors, expansion loops, supports, expansion joints, make-up water, vents, drains, controls, etc., will be provided as required for the piping system.

C. Steam And Condensate System:

1. Steam and condensate piping system for distributing steam and condensate to and from heat exchangers, domestic hot water heaters, unfired steam generators etc., including piping, valves, traps, strainers, vents, expansion joints, expansion loops, anchors, etc., will be provided.

D. Pumped Condensate System:

1. Gauges, thermometers, gauge cocks, thermometer wells, shut-off valves, balancing valves (for condensate pump discharge only) and other instruments will be provided for each piece of equipment for operation,

2. maintenance and balancing purposes.
2. Guides, anchors, expansion loops, supports, expansion joints, vents, drains, controls, etc., will be provided as required for the piping system.

E. Pipe Cleaning and Testing:

1. All piping systems will be thoroughly cleaned and flushed with temporary start-up conical screen filter and proper chemicals as required.
2. All piping systems will be tested for pressure and leakage.

F. Water Balance:

1. All hydronic systems will be balanced for specified design flow rate and system pump head, including submitting balancing reports.

1.10 BUILDING CONTROL SYSTEMS:

- A. The Building Control System shall be a Direct Digital Control System with electronic actuation, which will be tied into the Campus systems to perform all the control routines required. All system components shall be industrial or commercial grade as specified. Instrument characteristics such as hysteresis, relaxation time, span, minimum and maximum limits shall be coordinated so that the control system will operate smoothly and accurately throughout the design range. The system local control panel shall be a "stand-alone" unit at each mechanical system area.
- B. All temperature control and equipment interlock wiring, including conduits, shall be provided as required.
- C. The central control panel will provide start-stop-run indication for all major items of building equipment with run-time and critical alarms. Smoke detection alarms and other related and fire command system requirements will be provided under the Electrical Section.
- D. Critical alarms will include, but not necessarily be limited to, the following:
 1. Pump failures.
 2. Fire alarm control panel alarm condition. (Upon receiving alarm signal from Fire Alarm Control Panel (FACP), building HVAC equipment fire and life safety mode of operation will be activated as required.)
 3. Freeze indication at coils.
 4. Exhaust fan failures.
 5. Return fan failures.
 6. Supply fan failures.
- E. Each fan system, water system, etc., will be provided with main control panels and sub-panels to mount all required thermostats, thermometers, gauges, relays, switches, timers, regulators, receivers/controllers, and sub-master controls, with proper identification of the control devices.
- F. Chilled water coil control will be with two-way modulating type control valves with pump for minimum flow conditions.

- G. Freezestat with manual reset will close outside air dampers, stop fans and activate alarm.
- H. All wall mounted room thermostat covers will be tamper-proof. Thermostats can be locally adjusted or no adjustment at Agency direction.
- I. Typical zone variable volume air terminal unit will be controlled by wall mounted DDC room thermostat to modulate terminal unit and reheat control valve in VAV reheat systems, and a dual duct mixing box for VAV Dual Duct Systems.
- J. Air handling system. shall be controlled from supply duct air flow measuring stations as well as system static pressure sensors to modulate the supply and return fans through its variable frequency drive.

1.11 MATERIALS

A. insulation:

1. Glass fiber type pipe insulation with all-service jacket will be provided for chilled water piping, heating hot water piping, steam and condensate piping and condensate drain piping.
2. 2" hydrous calcium silicate insulation with ½" hard finish insulating cement and covered with presized glass cloth jacket, will be provided for diesel exhaust piping and mufflers.
3. 1-1/2" external insulation shall be provided for all air conditioning supply ducts and outside air ducts. Internal duct lining will not be used.

B. Pumps:

1. Pumps will be single stage, end suction centrifugal type, complete with motor, cast-iron casing, bronze impeller, seals, casing, and impeller wearing rings, cast-iron or steel base, stainless steel shaft supported on ball bearings and direct connected through flexible couplings.
2. Pumps in chilled water and hot water pump packages shall be end suction, frame-mounted type.
3. Pumps serving air handling unit cooling coils and preheat coils shall be in-line type.
4. Mechanical seals will be provided for pumps.
5. All pump motor selections will be based on non-overloading through the full range of the pump curve.

C. Pump Packages:

1. Building chilled water and hot water pumping will be by pump packages. Packages will be duplexed type, prepiped with suction diffusers, check valves and shutoff valves, complete with pumps, variable frequency drives and controls, mounted on a common base.

D. Piping Materials:

1. Chilled water piping

- a. Schedule 40 black steel with screwed fittings for 2 inch sizes and below or Type L copper with solder fittings.
 - b. Schedule 40 black steel with welded fittings for 2-1/2" sizes and above.
 2. Steam piping – Schedule 40 black steel with screwed fittings for sizes 2 inch and smaller and welded fittings for sizes 2-1/2 inch and above.
 3. Steam condensate and condensate pump discharge piping – Schedule 80 black steel with screwed fittings for sizes 2 inch and smaller and welded fittings for sizes 2-1/2 inch and above.
 4. Hot water heating piping.
 - a. Type L copper with solder joints 2" size and below.
 - b. Schedule 40 black steel with welded fittings for 2-1/2 inch sizes & above.
 5. Use dielectric couplings between dissimilar metals.
- E. Motors:
1. All motors will be built with NEMA Standard and high temperature winding insulation. Capacitor will be provided to maintain power factor of 0.9 minimum. Motors shall be premium efficiency type.
- F. Ductwork:
1. All air distribution ductwork will be galvanized sheet metal and of construction to comply with ASHRAE Standards.
- G. Flexible Ducts:
1. Factory fabricated assembly consisting of all aluminum flexible duct, corrugated, folded flat and knurled, and a 1-1/2 inch thick mineral wool insulation blanket.
 2. Omit the insulation on flexible ducts in return and exhaust duct systems.
- H. Unit Heaters:
1. Horizontal or vertical type hot water unit heater complete with fan, motor, and remote thermostat as required.
- I. Air Terminal Units:
1. Variable air volume, double wall construction so that no insulation is exposed to the airstream, single duct boxes, pressure independent with DDC Controls, maximum and minimum adjustment dials, adjustment minimum air volume stops, low leakage (less than 3% with 4" S.P.) and low pressure drop, and hot water heating coils.
- J. Humidification:
1. Steam humidifiers will be provided for each air handling unit, complete

with steam dispersion grids, distribution piping, condensate return system, drain piping, humidistats, high limits, limit alarms, controls, etc.

1.12 NEW INSTRUCTIONAL BUILDING EQUIPMENT SIZING CRITERIA

- A. Large Gross Anatomy Air Handling Unit (Modular, Constant Volume, Single Zone, Reheat Type)
 - 1. 20,000 cfm at 3 inches static pressure, 20 HP supply fan.
 - 2. Preheat coil: 45 square feet, 2 rows, 6 fpi, 53 gpm hot water flow.
 - 3. Humidifier grid: 45 square feet, 571 #/hour steam.
 - 4. Cooling coil: 66.6 square feet, 8 rows, 11 fpi, 240 gpm chilled water flow.
 - 5. Heating coil: 45 square feet, 1 row, 10 fpi, 32 gpm hot water flow.
- B. Small Gross Anatomy Air Handling Unit (Modular, Constant Volume, Single Zone, Reheat Type)
 - 1. 3,000 cfm at 3 inches static pressure, 3 HP supply fan.
 - 2. Preheat coil: 6 square feet, 2 rows, 6 fpi, 8 gpm hot water flow.
 - 3. Humidifier grid: 6 square feet, 86 #/hour steam.
 - 4. Cooling coil: 9.6 square feet, 8 rows, 11 fpi, 36 gpm chilled water flow.
 - 5. Heating coil: 6 square feet, 1 row, 10 fpi, 5 gpm hot water flow.
- C. Lecture Room Air Handling Units - Two Required (Each) (Modular, VAV, Single Zone Type)
 - 1. 3,500 cfm at 3 inches static pressure, 3 HP supply fan.
 - 2. 3,500 cfm at 1.5 inches static pressure, 1.5 HP return fan.
 - 3. Preheat coil: 6 square feet, 2 rows, 6 fpi, 8 gpm hot water flow.
 - 4. Humidifier grid: 6 square feet, 44 #/hour steam.
 - 5. Cooling coil: 9.6 square feet, 8 rows, 10 fpi, 24 gpm chilled water flow.
 - 6. Heating coil: 6 square feet, 1 row, 10 fpi, 12 gpm hot water flow.
- D. Building Air Handling Unit (Modular, VAV Single Duct Type)
 - 1. 36,000 cfm at 6.5 inches static pressure, 60 HP supply fan.
 - 2. 36,000 cfm at 1.5 inches static pressure, 20 HP return fan.
 - 3. Preheat coil: 45 square feet, 2 rows, 6 fpi, 39 gpm hot water flow.
 - 4. Humidifier grid: 45 square feet, 448 #/hour steam.
 - 5. Cooling coil: 76.9 square feet, 8 rows, 11 fpi, 214 gpm chilled water flow.
- E. Large Gross Anatomy Lab Energy Recovery System
 - 1. 20,000 cfm size, 500 fpm face velocity, 36 square feet per side enthalpy wheel.
- F. Small Gross Anatomy Lab Energy Recovery System
 - 1. 3,000 cfm size, 500 fpm face velocity, 6 square feet per side enthalpy wheel.
- G. Large Anatomy Lab Exhaust Fans - Two Required (Each)
 - 1. Strobic Air Type, 20,000 cfm at 2.75 inches static pressure, 20 HP.
- H. Small Anatomy Lab Exhaust Fans - Two Required (Each)

1. Strobic Air Type, 3,000 cfm at 2.75 inches static pressure, 5 HP.
- I. Building Exhaust Fan
 1. SWSI Centrifugal Type, 5,000 cfm at 1.5 inches static pressure, 3 HP.
- J. Stairwell HVAC Systems
 1. Mitsubishi "Mr. Slim" Type split system, 3 tons nominal capacity.
- K. Unfired Steam Generator (Skid Mounted, Vertical Configuration)
 1. 1,200 #/hour, 100 psig entering steam, 10 psig leaving clean steam
- L. Shell and Tube Heat Exchangers - two required-100% standby (each)
 1. 4,800 #/hour of 0 psig steam, 240 gpm hot water, 140°F EWT, 180°F LWT.
- M. Building Chilled Water Pump Package (540 gpm total capacity):
 1. Two pumps, each at 270 gpm at 85 ft head, 10 HP
- N. Building Hot Water Pump Package (240 gpm total capacity):
 1. Two pumps, each at 240 gpm at 55 ft head, 7.5 HP
- O. Total Building Steam Load: 6,000 #/hour.
- P. Total Building Chilled Water Flow: 540 gpm. END