

1 General

.1 Life Cycle Costs Analysis

- .a A 30 year life-cycle cost analysis shall be provided and submitted at the Design Development Stage of Design with final recommendation of type HVAC system to be used.
- .b Analysis shall include at least three (3) alternates along with integrated studies of the following:
 - 1. Building construction material.
 - 2. Building orientation.
 - 3. Usage schedules.
 - 4. Lighting.
 - 5. HVAC Equipment.
 - 6. Maintenance Costs.
 - 7. Fuels.
 - 8. Other factors relating to initial capital costs
- .c The life cycle costs study shall include (but not limited) to the following for each alternate study:
 - 1. The initial cost of the mechanical system, including electrical work, and miscellaneous building costs related to the mechanical system.
 - 2. First year utility costs for Heating Energy, Cooling Energy, Interior Building Lighting, Domestic Hot Water, and all other Energy Sources.

.2 System Requirements

- .a Where future expansion is planned in the initial design of a facility the Engineer shall provide adequate additional capacity and connection points in the mechanical design. The additional capacity shall be clearly noted in the equipment schedules.
- .b All points for future connections shall be clearly shown and labeled on the drawings with the capacity (GPM, Tons, Kw, etc.) that is available at each connection point.
- .c Access to mezzanine mechanical room shall be stairwell, (not ships ladder) leading up to the mezzanine mechanical room with a minimum width of 4'-0".
- .d Design insulated walls around all mechanical rooms.
- .e Provide floor drains in mechanical room floors.
- .f Locate noisy equipment (i.e. chillers, cooling towers, pumps, etc.) in locations so as not to disturb neighbors.
- .g All water piping shall be located a minimum of 10 ft. from electrical Switchboards and panel boards.
- .h The electrical contractor shall provide all power wiring to each piece of mechanical equipment. The mechanical contractor shall furnish all starters and disconnects to turn over to the electrical contractor. Mechanical contractor is to make final connection to each piece of mechanical equipment.
- .i Avoid the use of roof mounted exhaust fans on steep-sloped roofs.
- .j Roof mounted exhaust fans shall be secured to the roof curb with a minimum of 2 stainless steel fasteners, and EPDM washers for each side of the roof curb.
- .k Air side economizers shall be used where possible.
- .l Critical facilities shall have redundancy in equipment to provide heating and cooling.
- .m Low-leakage type outdoor air dampers shall be used to minimize air infiltration with a maximum leakage rate of ½ of 1% at 4 in. WG.
- .n Specify plug fans. Vane axial fans are acceptable only in low static conditions.
- .o Design the HVAC system so as to provide building relative humidity levels less than 60% at all times.
- .p Rooftop units are not preferred, but may be utilized at the written approval of the owner.
- .q Label all shut off valves on ceiling grid or access door with Valve Number, System & Area Served.

- .r Label all VAV boxes on ceiling grid or access door with BAS VAV point number. Associated thermostats shall be labeled with BAS VAV point number.
- .s Proprietary Systems shall not be designed or specified.
- .t Variable refrigerant systems will not be considered.
- .u All exterior equipment supports shall be galvanized.
- .v All equipment suspended from ceiling must be supported by building structure.
- .w Wall mounted hot water unit heaters shall be installed in each mechanical room, each electrical room, and each sprinkler riser room. Recessed cabinet type hot water heaters shall be installed at the bottom of each stairwell. Electric unit heaters may be used only where heating hot water is not available
- .x Refer to Division 24 for the Building Management (BMS) specifications. These specifications are provided to the designer to be revised and edited as required for each individual project.
- .y Sub-meter hot water, chilled water, gas supply, equipment, lighting, and plug load electrical panels where interconnecting systems serve multiple buildings and fuel oil/natural gas supplying boilers. Utilize BACnet and connect to BMS.
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.3 Codes & Standards

- .a Comply with applicable provisions of the most recent “North Carolina Building Code: Mechanical Code”.
- .b Comply with the most recent ASHRAE 90.1 “Energy Standards for Buildings,” ASHRAE 62.1 “Standards for Ventilation and Indoor Air Quality,” and ASHRAE 55 “Thermal Environmental Conditions for Human Occupancy”.
- .c Comply with the Wake County “Guidelines for Design and Construction of Energy-Efficient County Government Facilities and Schools”.
- .d Comply with NFPA Codes and Standards.
- .e Pressure vessels shall be ASME labelled and installed in accordance with the “ASME Boiler and Pressure Code”
- .f Comply with all applicable ANSI standards.
- .g Apply ASHRAE 189.1 “Standard for High Performance Green Buildings” where applicable.
- .h All products specified and installed shall bear the label of UL or other North Carolina recognized third party testing agency.
- .i Design and installation shall be compliant with the requirements of the “local authority having jurisdiction.”
- .j Comply with USGBC LEED requirements where applicable.
- .k Design of HVAC system and selection of equipment shall be based on life cycle cost considerations appropriate to the size and type of facility.

2 Products

.1 Equipment Selection

- .a The selection of all HVAC systems shall be approved by Wake County at the schematic design phase.
- .b **Motors**
 1. All motors shall be high efficiency type.

2. Where appropriate, air handling unit supply and return fan motors, secondary chilled water pump motors, and heating hot water pump motors will be provided with variable frequency drives and independent manual line voltage by-pass controls.
3. VFD Motors shall have grounding rings, be inverter rated with a minimum service factor of 1.15.
4. The primary chilled water pump, primary hot water pump motors, and exhaust fan motors will primarily be constant speed motors.

.c Vibration Isolation

1. Each base mounted pump and each fan shall be installed with appropriate vibration isolation. Refer to ASHRAE vibration isolation standards.
2. Vibration isolation pads will be provided for all air cooled chillers.
3. Piping shall be isolated with spring isolators for 50 linear feet of pipe from each pump and any vibrating equipment.
4. Rubber flexible connectors shall not be used at base mounted pumps. Provide braided stainless flex type connectors only.
5. Heating Hot Water flexible connectors shall not be insulated.
6. Each air handling unit and individual fan shall have flexible duct connectors.

.d Piping Insulation

1. Heating hot water and chilled water piping shall be insulated with two (2) inch minimum (or as required by the NCSBC) fiberglass insulation with air service jacket sized for painting and stenciling in concealed spaces except as noted herein. PVC or canvas jacketing shall be provided on piping in mechanical spaces and any location where the piping is exposed. Final selection of jacket type to be determined during design.
2. Two (2) inch minimum cellular glass insulation with service jacket shall be used on all exposed piping risers up to eight (8) feet of finished floor elevation.
3. Any hydronic piping installed above ground and exposed to weather shall have aluminum jacket and heat tracing.
4. Provide rigid insulatory blocks at supports and hangers.

.e Duct Insulation

1. All supply, return, and outdoor air ductwork shall be insulated with external insulation.
2. Exhaust, and relief air ducts shall not be insulated.
3. All supply, return, and outdoor air ductwork in mechanical rooms will be insulated with rigid board external insulation and prepared for painting.
4. The only lined elements allowed in the duct system are prefabricated transfer return air transfer ducts as required for privacy sensitive areas.
5. All concealed ductwork shall be insulated externally with fiberglass insulation per the NCSBC.

.f Equipment Insulation

1. Install mineral fiber insulation at pumps, heat exchangers, tanks, separators, and other equipment as required.
2. Install field applied jackets on all insulation, both factory and field installed.

.g Hydronic Piping

1. All piping to be run parallel and at right angles to walls, ceilings, floors and building structure.
2. Chilled, hot water, condenser and cooling tower hydronic piping will be welded black steel for piping larger than 2" and Type K copper for piping 2" and smaller.
3. Condenser water piping shall be welded black steel.
4. Condensate drain piping shall be copper.
5. Galvanized piping will not be permitted.

6. Underground chilled, hot, and condenser water piping shall be double wall copper or black steel prefabricated factory insulated piping.
7. Pipe size >3" provide butterfly or <2-1/2" provide ball type isolation in the main chilled and hot water piping at each mechanical room.
8. Gate valves **shall not** be provided in any piping system. Ball or butterfly valves are to be provided in lieu of gate valves.
9. Where combination valves are installed, provide shut off valves on each side of combination valve.
10. Two position control valves need feedback where available.
11. In all buildings with multiple zones or multiple stories install isolation shut off valves for each zone or story near piping risers in a designated valve closet or other accessible location. Height of valves installed shall be at 60" AFF. Coordinate locations with Wake County.
12. Install valve tags on all valves and provide schedule.
13. No dielectric unions are to be installed. Use copper only or where black steel is stubbed out, use a brass flange or bronze unions.
14. Use of orings is not acceptable.
15. Combination valve packages are not acceptable.
16. Groove and cut joint piping is not acceptable.
17. Each piece of equipment shall have valves, unions or flanges, for isolation and easy removal.
18. Auto flow valves shall not be installed. Provide circuit setters to facilitate hydronic balancing.
19. All piping to be supported direct from structure.
20. Provide high point drains in Mechanical Rooms.
21. Coordinate with Plumbing to provide drains in all Mechanical Rooms.
22. The majority of the controls valves shall be two-way valves with appropriate number of three-way valves installed in the hydronic piping system to provide minimum flow rates for the associated pumping system.
23. No pressurized piping shall be installed under slab of any building.
24. Split rings are not acceptable for chilled water supports with clevis hangers.
25. Trapeze hangers shall not be installed.

.h Refrigerant Piping

1. Refrigerant piping shall be copper and installed between the interior air handler and the outdoor heat pump/condensing unit.
2. Piping to be sized per manufacturer's recommendations.
3. Refrigerant piping shall be insulated with cellular glass and where exposed to the weather, a PVC jacket shall be applied.

.i HVAC Pumps

1. Pumps >2HP shall be base mounted, end suction, 1750 RPM or 3500 if required, variable speed type pumps or >2HP in-line, constant or variable speed type pumps.
2. In critical facilities or facilities in excess of 30,000 sq. ft., a minimum of two variable speed base mounted heating hot water pumps shall be provided, each size for the anticipated heating water flow associated with the block heating load of the building. Each pump shall be sized for 100% flow.
3. One primary, base mounted, end suction, constant speed pump shall be provided for each chiller and cooling tower.
4. One Standby, variable speed, base mounted, end suction, secondary distribution pump, sized for 100% of the chilled and condenser water flow associated with the block load of the building may be provided. Each facility will be reviewed for this design as required.
5. All pumps to be minimum 90% efficiency.

6. All variable speed pumps to be base mounted. Constant speed pumps may be in-line.

.j Variable Frequency Drives

1. Air handling unit supply and return fan motors, secondary chilled water pump motors, and heating hot water pump motors shall be provided with variable frequency drives.
2. Drives shall have independent manual individual by-pass features with manual reset safeties and (3) three contacts.
3. FLN interface to DDC controls shall be provided with all variable frequency drives.
4. Provide BACnet IP.
5. Drive rated motors with grounding kit.

.k Chemical Water Treatment

1. Each separate heating water and chilled water system will be supplied with a shot feeder for chemical treatment.
2. Condenser water treatment shall use injector pumps and appropriate chemical treatment based on water test results.
3. Reclaim water where utilized will be supplied with a shot feeder for chemical treatment.
4. Water treatment shall be provided by Wake County's current water treatment provider.

.l Boilers

1. The primary heating equipment will be high efficiency natural gas boilers. Dual fuel with natural gas as the primary and fuel oil as the secondary fuel shall be provided on critical facilities or as required by the owner. Where boilers are larger than 3 MMBTU/hr or usage greater than 6000 decatherms per year dual type fuel shall be utilized.
2. Where natural gas is not available LP gas should be considered.
3. All critical facilities shall have redundancy.
4. Boiler system shall have a high turn down with individual boilers installed at with 10 – 1 turn down.
5. Summer boilers shall be provided where required to maintain boiler system efficiency.
6. Multiple boilers shall have a central boiler control panel.
7. The heating water system will be set up as a primary/secondary system with the secondary system sized for the building block load heating requirement. The primary pump system shall be constant speed pump and the secondary system pumps shall be variable speed pumps with variable speed drives.
8. Units will be fitted with stainless steel flues.
9. Boilers shall be cast iron or stainless steel. Aluminum Boilers or sections are not acceptable.
10. Provide electronic controls and BACnet IP when available.
11. Air permit applications where required must be submitted and final approvals obtained.

.m Air Cooled Water Chillers

1. Air cooled chillers shall be scroll type units with integral BACNET capability.
2. Preferred refrigerant is 134A or 410.
3. Units shall be provided with sound packages where required to comply with the sound ordinance of the local jurisdiction, protective grilles for the compressor sections, and louvers for the air intake of the condenser fans. Maximum decibel level for air cooled chillers cannot exceed local jurisdiction sound ordinance.
4. Single point connection shall be provided.
5. Five (5) year warranty.
6. Provide external phase protection.
7. All chillers to be screened within a secure courtyard.

.n Water Cooled Chillers

1. Water cooled chillers shall be centrifugal units with integral BACNET capability.
2. Refrigerant monitoring systems shall be provided in each water cooled plant unless exception granted by owner.

3. Preferred refrigerant is 134A or 410.
4. Single point connection shall be provided.
5. Five (5) year warranty.
6. Provide external phase protection.
7. Screw chillers are not acceptable.

.o Water Cooling Towers

1. Water cooling towers shall be all stainless steel, factory assembled, and designed for cross flow. Rails, support plat forms, etc. shall be stainless steel.
2. Units shall have integral basin heaters and variable speed motors for the fans.
3. Integral float switch control shall be provided for make-up water.
4. Access must be OSHA compliant, shall be provided from two sides with integral access ladders, walk ways and platforms.
5. Include internal PVC basin sweeper piping and centrifugal solids separator.
6. Provide cooling tower blow down valves.
7. Fill materials shall be corrugated rot, decay, biological attack resistant PVC type and installed by the manufacturer.
8. Make up water shall be metered and monitored by the BMS.
9. All cooling towers to be reclaimed water certified.

.p Air Handling Units

1. Modular, double wall, variable air volume air handling units shall be installed in mechanical rooms. The units shall be configured to operate with a full outdoor air economizer and will primarily include the following modular sections: a return air fan sections, a relief air mixing box section, an outdoor air mixing box section, a filter section with 2"pre-filter, 65% cartridge filters, a hot water heating coil section, an access section, a chilled water coil section, and a supply fan section.
2. Appropriate vibration isolation shall be provided for fan sections.
3. Cooling coils shall be selected with a minimum water velocity of 4 fps and a maximum of 500 fpm.
4. Provide supply fans with current sensors in lieu of DPS for status signal.
5. Provide preheat coils on all units with economizers and outside air intake.
6. Constant volume units with no economizer shall have a reheat coil.
7. Large and custom built units shall have two (2) means of egress.
8. Provide manual reset on freezestat. BMS to monitor status and shut down unit.

.q Split Systems

1. Steel, finished with baked enamel, removable panels for access, weep holes, and mounting holes in base.
2. Both indoor and outdoor units shall have copper coils with aluminum fins where available. No aluminum tubing where copper is available.
3. Brass service valves, fittings, and gage ports.
4. Hermetically sealed scroll, two-speed compressor motor where available.
5. R-410A Refrigerant.
6. Low ambient kit.
7. Variable refrigerant flow systems shall not be installed.
8. Automatic reset kit.
9. Five (5) year warranty compressor warranty.
10. Two (2) year equipment and labor warranty.

.r Computer Room Air Conditioning Units (CRAC)

1. Steel, finished with baked enamel, removable panels for access, and mounting holes in base.
2. Both indoor and outdoor units shall have copper coils with aluminum fins.
3. Brass service valves, fittings, and gage ports.

4. Hermetically sealed scroll, two-speed compressor motor.
5. R-410A refrigerant, low ambient kit, and automatic reset kit shall be provided where spilt system air condensers are utilized.
6. Five (5) year warranty compressor warranty.
7. Two (2) year equipment and labor warranty.

.s Power Ventilators

1. Toilet and general exhaust fans shall be rooftop exhaust fans or inline fans located in the ceilings in appropriate spaces.
2. Each fan located in the ceiling shall be located so as to be readily accessible through ceiling tiles or access doors in hard ceilings.
3. Fans may be direct drive below 2 HP and shall be belt driven at 2 HP and above.
4. Each direct drive fan shall have an integral speed controller.
5. An electrical disconnect shall be provided at the fan.

.t Ductwork

1. Ductwork between the air handling units and terminal units shall be medium pressure.
2. All other ductwork shall be low pressure.
3. All exposed ductwork in occupied spaces shall be double wall insulated spiral type.
4. Maximum length of 5'-0" flexible duct shall be used for final connections to individual air distribution devices.
5. Lined ductwork is allowed only in return air transfer sound trap ducts.
6. Designer shall specify allowable means of attachment. Hangars shall not be attached to metal deck systems.
7. Ductwork connected to air handlers shall be double wall insulated from the air handle to a distance of 50 – 75 feet.
8. Flex connections shall be used at air handlers and fans.
9. Manual dampers shall be provided at branch duct serving each air distribution device.
10. All duct shall be suspended direct from structure.
11. Minimum thickness and pressure ratings shall be per current SMACNA standards.

.u Air Terminal Units

1. Temperature control to individual perimeter zones shall be regulated by single duct, variable air volume, terminal units with hot water heating coils controlled by wall mounted temperature sensors.
2. Temperature control to individual interior zones shall be regulated by single duct, variable speed air volume, terminal units with hot water heating coils controlled by a wall mounted temperature sensors.
3. Electric reheat shall not be installed.
4. Fan boxes shall be installed on all external zones. Combination flow units shall not be installed.
5. Provide reheat on all boxes except those serving telecom and electrical rooms.

.v Air Distribution

1. All aluminum two x two, louver faced or slot diffusers shall be installed in suspended ceilings.
2. Slot diffusers shall be installed in ceilings above window and building entrances.
3. Where ductwork is exposed in occupied areas, round jet type diffusers shall be installed.
4. Manual dampers shall be installed at all branch connections from main ducts.
5. Installation of opposed blade dampers shall be avoided in air distribution devices.

.w Sound Attenuation

1. Provide sound attenuators sized at 500 fpm shall be provided as required for noise reduction in noise sensitive areas.

.x LP Tanks

1. Tank to be located a minimum of 75' from building and screened.
2. If tank is underground, it must be installed in a vault.

3 Execution

.1 Design Requirements

- .a** Pipe Labels and Identification shall be provided as noted in the Pipe Label & Identification Chart in Division 23.
- .b** All exposed piping shall be painted in accordance with the Pipe Label & Identification Chart in Division 23.
- .c** Engraved phenolic laminated labels shall be provided on all equipment.
- .d** Equipment name plates (preferably metal) with raised or depressed images for permanent attachment shall list the following:
 1. Manufacturer, product name, model number, and serial number.
 2. Capacity, operating and power characteristics, and essential data
 3. Labels of tested compliances.
- .e** Install bar code labels on boilers, furnaces, heaters, pumps, compressors, chillers, condensers, heat exchangers, coils, evaporators, cooling towers, fans, air handlers, and VAV boxes. Bar code will be installed by WC-GSA or Commissioning Agent.
- .f** All belt driven equipment shall be provided with a new belt at final completion and a new spare belt shall be turned over as attic stock.
- .g** All filters shall be replaced at final completion and a spare set of filters shall be turned over as attic stock.
- .h** All warranties shall commence for the date of Substantial Completion, not the start-up date of the equipment.
- .i** Any building systems started and operated to provide conditioned air during construction shall be evaluated, serviced, and cleaned so that all equipment is like new at substantial completion.
- .j** Label the grid or access panels at all concealed equipment in accordance to the "Grid/Access Panel Labeling Convention" supplement in Division 23.

.2 System Testing and Operations Manual Review

- .a** Each piece of equipment and each specific operation of the Heating, Ventilating, and Air Conditioning system shall be tested, adjusted, and balanced to meet design requirements.
- .b** Certified Test and Balance documentation shall be provided by a NEBB or AABC certified agency and submitted to the designer and Wake County.
- .c** Contractor shall submit a copy of each O&M Manual to designer prior to 80% billing.
- .d** All close-out documentation, including as built drawings, shall be submitted within 60 days or substantial completion.