2.8 Mechanical Systems

2.8.1 General Considerations

General Guidelines

Intent
This section explains the university's expectations regarding the design of effective mechanical systems. Daily operation of the building depends on durable and efficient mechanical systems.

Resources
Resources available to designers are the following:

NC Building Code
ASHRAE and SMACNA Guidebooks
NC State Construction Manual
Vendor's literature
On-campus Facilities Design and Operations personnel

Documentation
Sufficient information must be included on the plans and specifications not only to construct the project with few or no change orders, but to allow future troubleshooting and expansion of design work. Paths of access to equipment should be shown on the drawings. Where two or more services are to occupy the same mechanical room, proper coordination is necessary. Designers are expected to field-verify all existing conditions, and not to rely on available prints.

Design Criteria

General Characteristics
Designers engaged in providing the design of mechanical systems for campus buildings and grounds should plan energy efficient systems which are long-lived and easy to operate and maintain. The scope of new projects shall include any necessary campus utility extensions and relocations to serve the building being designed.

When extensions and/or connections are made to the building, the designer should concentrate and run such utility lines under sidewalks or parallel to roads where they can be accessed in all weather conditions. All efforts should be made to avoid disturbance of any area within the drip line of trees when routing underground lines.

Planning to Reduce Site Clutter
The designer must take every effort to consolidate mechanical and electrical equipment on the building site. Consideration must be given to organizing the equipment so that it is easily accessible to service areas and service-vehicle parking. In addition, the equipment must be treated architecturally in a way that does not detract from the appearance of the building or the landscape. Schematic and design development drawings must clearly show how this will be accomplished.

Planning for Ease of Operation and Maintenance

See section 2.6.5 Mechanical and Electrical Room Standards and 2.8.10 Equipment Access and Maintainability in this document.

Mechanical System Painting and Identification

Pipe can either be stenciled with contents and direction of flow or the following color coding can be used:

A. Paint all equipment and piping exposed to view in finished areas including hangers and attachments. Do not paint sprinkler heads or obscure nameplate data.

B. Color code piping in mechanical rooms by covering surface with paint; color code piping in other areas by banding pipe at frequent intervals with the specified color.

C. Place and identification of flow areas on all pipes or pipe covering to signify the direction of flow, whether the piping is exposed or concealed above ceilings.

D. Provide brass valve tags for all valves and a schedule under glass in the mechanical room.

E. Provide manufacturers' standard bright-colored underground plastic line marker consisting of multiply tape with sold aluminum foil core 6" wide x 4 mils thick. Tape shall be labeled for type of service. Install 12" below finished grade over all exterior utilities.

The designer is requested to utilize the following color coding for various pipes and pipe insulation:

Fire Protection Riser	Red
Fire Protection Distribution	Same as surrounding
Steam Supply	Orange
Condensate Return	Aluminum
Potable Cold Water	Dark Green
Potable Hot Water	Dark Yellow (Gold)
Non-Potable Water	Bright Yellow
Lab Cold water	Light Green
Lab Hot Water	Light Yellow
Chilled Water	Dark Blue
Condenser Water	Light Gray

Natural Gas	Light Yellow
Compressed Air	Dark Brown
Vacuum	Beige
Drain, Waste, and Vent	Same as surrounding
Electrical	Same as surrounding

2.8.2 Life Cycle Cost and Energy Consumption

General Guidelines

Intent
The primary purpose of life cycle costing is to provide the University with information on a comparative basis between different system designs and components. The purpose of energy consumption calculations is to provide information to the university supporting the estimated cost of operation for the project. Resources available to the designer are the university's utility rates, which can be obtained through UNC-Pembroke Physical Plant.

Design Criteria
The designer shall provide an Executive Summary and supporting calculations for the life cycle cost of all major components of the facility's mechanical, lighting, and energy management control Systems. The designer shall provide these costs over a 20-year period Broken-out by year and shall include any cost for manufacturers' recommended periodic maintenance in the supporting calculations.

The designer will also provide life cycle cost analysis for all system options and alternates as determined by the scope of the project.

With this information, the designer will include cut-sheets for all proposed equipment for the mechanical, lighting, and energy management/control systems components.

Energy consumption calculations can be included in the summary, provided the supporting calculations are included as an attachment. the energy consumption calculations should cover a 20-year period and be listed by years 1 through 20. The designer will provide an energy consumption analysis for all system options and alternates as determined by the scope of the project.

2.8.3 Energy Conservation and Building Automation Systems

General Guidelines

Intent
The purpose of the energy management system is to operate the mechanical system in as efficient manner as possible and still meet the indoor environmental requirements for the facility's

operation. The system design should incorporate Direct Digital Control (DDC) of all major heating, ventilation, and air conditioning equipment and systems. The system design may also include pneumatic, electrical, or electronic controls for terminal units, VAV boxes, and similar equipment as necessary.

Documentation
Documentation shall include all specifications, drawings, and details necessary for a complete and operational system as installed. Detailed control drawings shall show all control points and provide detailed sequences (these should be shown on the plans in addition to being listed in the specifications).

Design Criteria
The University utilizes an Invensys central control system. All control systems shall be Lonmark and BACnet compatible and be compatible with this system.

The energy management system will feature multiple stand-alone local control units and unitary digital controllers and their respective field devices, interfaced to a building control unit via the manufacturers' local area network. The building control unit will be interfaced to the central supverisory station located in Physical Plant.

Pneumatic controls should be limited only to those functions which cannot be accomplished by electrical or electronic control.

2.8.4 Campus Water and Gas Distribution

General Guidelines

Intent
This section provides the designer with information on campus water, and gas distribution systems. In most cases on campus, these utilities can be furnished to the proposed building sire from nearby distribution systems.

Resources
Resources available to designers of these systems are drawings of existing systems held in Facilities Planning and Design. Also, the standard design manual for steam, water, and gas piping is the American Society of Plumbing Engineers Data Book and associated supplements.

On-campus design professionals and Physical Plant personnel can provide further information on specific sites. Facilities Planning and Design has detailed location information on many underground utility sites.

Also, please refer to the North Carolina State Construction Manual, section 112.3, For specific information on State Construction Office requirements.

Documentation
Documentation of designs should include detailed information on as-built drawings, existing conditions of distribution systems being connected to, and should provide the same level of detail on new installations. Profile drawings of underground utilities are required, as are locations of existing utilities which might be disturbed or encountered during excavation. Designers are required to update drawings to reflect as-built conditions upon completion of construction.

Design Criteria

General Considerations

All steam, condensate, and domestic water lines within the building envelope shall be insulated. Uninsulated mains or runouts shall not be used as heat sources. Chases and stack areas carrying heating lines in the building should be adequately ventilated to prevent overheating due to piping losses.

All connections to mains shall be valved, both at the connection to the main and at the building.

All services to new buildings are to be metered as described below.

All new piping shall conform to the color scheme sited in section 2.8.1 or be stenciled with type of service and direction of flow.

Campus Wide Distribution Systems

There is no central campus steam, hot water, or chilled water distribution. Each building must be designed to stand alone for these utilities. Campus wide domestic water and gas are the only available systems.

Campus Cold Water Distribution

Cold water is available from the university distribution systems (City of Pembroke). Delivery is through a pressure-reducing station which on the load site maintains a pressure of approximately 65psig . Any cost for tapping the main should be included in the construction contract. The line should be valved at the point of connection to main and at entry to building. All new buildings shall be provided with backflow prevention as required by the NC Building Code, and with water meters. Further information on campus plumbing system design can be found in section 2.8.5 of this document.

Campus Natural Gas Distribution

Natural gas is available from North Carolina Natural Gas and is generally distributed through a university owned system. Isolated locations may be served directly from gas company lines. Metering and lateral piping into each new building should be included in the contract. Tapping of mains should be performed by qualified contractors supervised by Physical Plant. The gas main pressure on campus should be verified before beginning design, but averages 5 psig.

Gas Distribution Piping

A gas distribution network must include a pressure reducing station that is valved at both sides. A gas meter should be located on the outside of the building. A 3-valve bypass should be supplied around the meter.

2.8.5 Plumbing System Design

General Guidelines

Intent

This section provides guidelines on the design of the university's plumbing systems. The prime focus of the design shall be durability, maintainability, and accessibility.

Resources

Resources available to designers of these systems include the following:

NC Building Code, volume II
ASPE Databook
On-campus design professionals

Documentation
Documentation should include details of all piping routings, including riser diagrams, and schedules showing fixtures and fixture units.

Design Criteria

General Guidelines
The following are general guidelines regarding design of plumbing systems:

1. Whenever possible, runout piping (both supply and waste) shall be exposed. The drawings are to indicate the general location and arrangement of the piping. Location and arrangement must take into account pipe sizing, friction loss, pump sizing and other design considerations.
2. All piping is to be installed free of sags and bends, and at right angles or parallel to building walls. Install tight to slabs, beams, joints, columns, walls, and other permanent elements. Locate groups of pipes parallel to each other, spaced to permit future connections and servicing of valves.
3. Exterior wall penetrations: seal pipe penetrations through exterior walls using sleeves and mechanical sleeve seals. pipe sleeves smaller than 6" shall be steel; those above 6" shall be sheet metal.
4. Interior wall penetrations: Maintain fire-rated integrity where pipes pass through fire-rated walls, partitions, ceilings, or floors. Fire-resistive fill materials and sealants are required.
5. Install dielectric waterway fittings to connect piping materials of dissimilar metals in wet piping systems.
6. Provide access panels to all plumbing chases. These should be clearly labeled, indicating the services contained within. They should be keyed with a standard mechanical room key.
7. Supply runouts shall be valved at the point of connection to main or riser, and valves must be accessible. Accessible stops should be furnished where each piece of equipment is to be connected.
8. Domestic water underground:
   2-1/2" and smaller: Use type K soft copper and wrought copper fittings with silver soldered joints (minimum 6% silver).
   3" and larger: Use cement-lined ductile iron with push on joints, except use mechanical joints at all elbows.
   Domestic water aboveground:
   1-1/4" and smaller: Use type L hard copper and wrought copper fittings with 95-5 soldered joints.
   1-1/2" - 2-1/2": Use type L hard copper and wrought copper fittings with silver soldered joints (minimum 6% silver).
   3" and larger: Use cement-lined ductile iron with mechanical or flanged joints.
9. All water lines are to be tested at 150 psi hydrostatically for a period of not less than 12 hours.

10. Cold and hot water meters shall be supplied in the mechanical

room of each building and should be located where they are easily accessible to a meter reader.

11. New buildings and major renovations shall include separate lab cold and water systems served by RPZ devices.

Domestic Cold Water Piping Design

The following general guidelines apply to the design of all cold water piping: Insulation shall be used on **all** cold water piping, including cooling water for air conditioning. Where sweating lines would damage or be detrimental to the building, waste lines should also be insulated. Insulation should also be considered for noise control purposes where sound from piping would be intrusive.

Domestic Hot Water Piping Design

Provisions shall be made for hot water lines to be free to expand without rubbing against masonry or concrete. Where hot water lines can come into contact with occupants, they shall be insulated. Insulation shall be of sufficient diameter to control heat, and shall be covered by vandal-resistant jacketing materials, painted to match background.

Sewer Piping Design

The following guidelines apply to the design of all campus sewer piping:

1. Sanitary and laboratory sewers from buildings shall be run out in separate lines. Dilution of acid waste is required. The lines, both sanitary and lab wastes, shall be installed so that the sewer flow empties into a manhole within 10 feet of the building. All waste lines should enter a manhole at the invert elevation of the manhole. All waste cleanouts must be accessible.
2. Floor drains in labs and research facilities shall empty into the sanitary sewer. Where soap suds and organic material are likely to enter an exterior drain, the exterior drain shall empty into the sanitary sewer. An area drain shall be placed at all dumpsters and tied into the sanitary sewer, but not located so as to drain a large surface area of stormwater.
3. Where floor drains are subject to receiving large amounts of of hot water (such as from boiler relief or blowdown), care must be taken to flash vent pipes properly to prevent steam from entering roofing material. The designer shall provide tempering water supply and automatic valve, where appropriate.

Water shall be tempered to 140 deg or less.

Fixture Design

The following guidelines apply to the design of all campus Fixture selection:

1. A diaphragm-type flush valve shall be used on all Urinals and water closets. Preferred manufacture is Sloan.
2. Plumbing fixtures stops shall be hand-wheel operated.
3. Flush valves on urinals and water closets must be Compliant with current ADA regulations.

4. Closet bowls shall be of the elongated pattern. American Standard is the preferred manufacturer.
5. Water closets should have a siphon jet action with 2 1/2" waterway.
6. Urinals should be vitreous china, wall hung.
7. Lavatories should be a porcelain-enameled cast iron, or, when mounted in a countertop, should be vitreous china.
8. Showers should be factory-assembled, surface-mounted, vandal-proof units of standard length, equipped with a nonscald pressure mixing valve, with single simple and pressure-actuated piston contained in the spindle, integral stops, brush finish stainless steel cover, 1/2" copper tubing to limit of the unit, and head mounted on institutional head bracket fitting.
9. Bathtubs, if used, should include a shower enclosure.
10. Hose Bibbs: The general contractor shall be responsible for furnishings covered boxes with locking devices for installing hose bibbs on the exterior walls of the building. The university will furnish the lock cylinders. One outlet should be located at each of the corners of the building, and if one side of the building is in excess of 200 feet in length, then a hose bibb should be installed in the center of the long side on both sides. Outside hose bibbs should be the key-operated freeze-proof type with a cast brass body. Hose bibb boxes should be stainless steel, and should be fully detailed on the drawings.

Toilet Rooms
Accessible toilet entrance doors, stall compartments grab bars, mirrors, lavatories, urinals, etc., in accordance with volume 1-C of the NC Building Code and the Americans with Disabilities Act Accessibilities Guidelines (ADAAG) shall be provided in all toilet rooms to the greatest extent possible for the greatest number of people. The layout of toilet rooms should include more than the minimum number of required items to make all mirrors, lavatories urinals, dispensers, etc.. accessible so that accessible items do not stick out as "separate but equal." Hot and cold water under sinks accessible to wheelchairs shall be insulated. There shall be a minimum of 5% of showers in any new facility made accessible.

2.8.6 HVAC System Design

General Guidelines

Intent
This section provides guidelines on the design of the university's HVAC systems. The overall goal should be to design systems which provide safe and adequate environments that meet the program for the space, utilizing as much as possible large centralized components rather than distributed systems. The prime focus of the system design should be maintainability, and the secondary focus should be energy efficiency.

Resources
Resources available to designers of these systems include the following:

NC Building Code, volume III
ASHRAE Guides

Associated Air Balance Council
SMACNA Guidelines
On-campus design professionals

Documentation
Documentation should include details of all equipment placement and Maintenance access, duct and pipe routing, floor and wall penetrations, Riser diagrams, and schedules of equipment.

Design Criteria

Outside Air Requirement
Each new or renovated system shall supply outside air per ASHRAE 62-1989.

General Guidelines
HVAC systems should be planned and designed as central station and built-up systems, with fewer and larger components, as compared to distributed or multiple package systems. The intent is to reduce the overall number of components that require maintenance, such as motors, fans, belts, filters, and compressors. central systems also imply mechanical rooms, chases, and outdoor areas dedicated to the servicing of equipment. This tends to reduce clutter, noise, and disturbances Mechanical systems shall be designed to provide future flexibility. As the usage of building spaces change, the mechanical system should be able to accommodate a reasonable amount of change and increase of load without requiring major renovation.

Design Conditions
The general design conditions for university buildings shall be as follows:

- Outdoor conditions, summer and winter:
  ASHRAE Design Conditions for Fayetteville NC
- Interior conditions:
  Winter 70 + /-2 degrees f; 35% RH, min;
  Summer 75 +/-2 degrees f, with 50% RH
- Special-purpose facilities will require special definition of appropriate interior design conditions.

Air Conditioning
Chilled water cooling should be used wherever practical for new projects and major renovations . Positively controlled outside air should be utilized for cooling wherever applicable, particularly where there are high internal loads, such as research equipment. Designers shall provide 100% outside air capability. Preheat coils are to be provided on all air handlers to prevent freezing. If hear reclamation is used, then preheat coils are to be located downstream of these coils. Size the preheat coils based on the possibility of failure of the heat reclamation coils.

Air Distribution
Makeup air should be provided to all spaces that have mechanical exhaust, and should be unconditioned as much as comfort and control will permit to conserve energy. Makeup air should be provided in accordance with ASHRAE standard 62-189 "Ventilation for Acceptable Indoor Air Quality." The location of air intakes shall be remote from any pollution sources, and the building air intake and exhaust outlets shall be remotely located from each other to prevent contamination.

Take special care to ensure that exhausts from hoods, emergency generators, cooling towers, boiler stacks, etc., is not pulled into the building through the makeup or fresh air intake.

Air distribution fans and ductwork for comfort conditioning systems should be low-pressure and low-velocity unless otherwise required and approved. Air filters used in routine comfort conditioning service should be the 2" thick "throwaway" type of standard sizes. They may serve as prefilters where higher efficiency filters are required.

It is desirable that all air filters used in one air handler, one project, or one building be of the same size and type to simplify stocking and replacement.

Metal opposed blade dampers shall be provided at supply diffusers and grills for balancing purposes, or suitable extractors or dampers installed in branch take-offs where take-offs are readily accessible and serve only one diffuser. air intake an exhaust grills should include aluminum hardware cloth.

Provide stationary weatherproof louvers at air intake ducts. In general, all air diffusion devices should be stainless steel, unless otherwise approved.

Designers are required to give serious consideration to noise reduction in air ducts. All air distribution ducts, unless otherwise approved, should be constructed of sheet metal of the appropriate gauge to the size, and lined either internally or wrapped to dampen sound.

Balancing of the System

Air and liquid distribution systems should be balanced and placed in proper operating condition by skilled personnel who have training and experience in working with such systems. The contractor should be prepared to show proof of the competence of personnel used for balancing.

Testing and balancing should be performed in accordance with applicable standards as published by the Associated Air Balance Council (AABC) or ASHRAE. Refer to section 3.15990 of this document.

Balancing devices should be kept away from supply/return grills to avoid noise. Balance reports are to be typed.

Refrigerants

In compliance with EPA requirements, it is unlawful to release Group I or Group II refrigerants containing CFC's and HCFCs into the atmosphere. This includes the refrigerants R-11, R-12, R-22, and R-500. When design work involves equipment containing these types of refigerants, the designer is expected to provide an analysis of whether it is more cost effective from a life-cycle point of view to 1.) replace this equipment or retrofit it to accept new refrigerants, or 2.) provide the necessary modifications to the mechanical room to contain leaks, and to provide the necessary monitoring systems. New systems containing refrigerants require the design of appropriate refrigerant venting and leak detecting alarm systems. These detection systems should report to the building fire alarm panel, if one exists.

Heating Systems

Heating in existing buildings should utilize the existing system. In new buildings, heating should be by means of a hot water boiler and hydronic distribution system. Boilers are to be high efficiency gas fired package boilers.

Controls should permit separate heating of individual spaces where feasible. Removable, fitted insulation jackets shall be provided to all pressure-reducing valves, and to all other large valves.

The discharge of relief valves should be piped to the outside of the building to a point that will cause neither personal hazard nor property damage.

Where temperature control valves are used, valves and controls should be by the same manufacturer.

Cooling Towers
The designer should consider locating the cooling tower, if any, away from occupied space and pedestrian walkways. Cooling towers should be screened or placed on top of the building for reasons of noise control, access, and overspraying cooling medium.

The design development drawing should clearly indicate where all external HVAC equipment will be located and how it will be screened or integrated into the building.

Cooling towers with long-life/low-maintenance options such as stainless steel basins and casings are preferred. The designer is to consider maintenance access to the tower, and provide railings and stairs as appropriate

Mechanical System Monitoring
The designer is required to include connection of mechanical systems to the campus automation system where available. The operation of building comfort systems should be monitored such that failure of the system to produce the desired heating or air conditioning will be reported by the university's computer control and monitoring system. Installation of a temperature sensor and associated wiring should be located in the chilled water line by the mechanical contractor. All other monitoring equipment and wiring should be included in the electrical contract. See in addition sections 2.8.3 of this document.
In certain instances it is highly desirable to monitor the operation of circulation pumps. Where flow or float switches or other devices are to be used for monitoring, they should be installed by the mechanical contractor, and included in this contract. Where monitoring devices for sump pumps are installed, they should be in the plumbing contract.

Smoke Detection in HVAC Systems
The designer is required to provide smoke detection systems which comply with the latest requirements of the NC Department of Insurance and with NFPA standards. These systems are required to be connected to the campus central monitoring system. See sections 2.8.3 and 2.8.8 of this document.

Chemical Water Treatment
Each new system must be protected by the installation of chemical water treatments where applicable. These systems should include automatic feeders and protect systems against corrosion, sedimentation, and organic organism growth.

Indoor Air Quality Concerns
Design should consider double-wall air handlers with foil face louvers to

improve indoor air quality.

2.8.8 Industrial Ventilation/Laboratory Ventilation System Design

General Guidelines

Intent
The primary purpose of fume hoods and other industrial ventilation systems is to protect the worker or researcher with air. The design should be considered on a case-by-case basis by the designer, after thorough investigation of the proposed usage and the materials to be used in the hood or system.

Resources
Resources available to designers of these systems include the following:

National Institute of Governmental Industrial Hygienists Design Manual
On-campus design professionals

Documentation
Documentation should include details of hoods; duct routing; fan selections; stack design and support; wall, floor and roof penetrations; materials; and other details required to describe the installation completely.

Design information and construction details are needed to evaluate proposed changes in use which occur over the life of the system. For this reason, materials and construction should be those that provide a long service life under severely corrosive conditions, since service conditions may later change from those initially expected.

Design Criteria

The ideal hood system will feature one fan per hood. This will eliminate problems with mixing contaminants. Fans should be located on the rooftop, so that all ductwork within the building envelope will be at negative pressure. Also, devices that require maintenance should be located outside the contaminated air stream as much as possible. The use of dampers as balancing devices is not permitted without prior approval. Hood exhaust systems should be designed using the velocity pressure method, and balancing should be done by adjustment of the fan sheave.

The exhaust duct shall be compatible with the materials to be used and shall be designed so that drainage will not collect in the duct. Also, mechanical joints are to be avoided. Welded stainless steel ductwork is required for all radioisotope work, and fire resistant fiberglass is required for perchloric acid work.

Other duct materials are to be considered on a case-by-case basis. The exhaust fan discharge stack should be vertical with a zero pressure rain cap with provisions for draining rain from the unit. If the fan housing is not designed to handle rain water, then the stack design should prevent rain from entering the fan housing. Fans should be belt driven, so that speeds can be adjusted.

Chemical fume hoods shall be designed to provide a continuous face velocity of 110 fpm +/-15 fpm at a sash height of 19". Remote exhaust systems shall be designed according to Industrial Ventilation Manual Guidelines relating to particle size and distance of the hood. Stack exit velocities shall not be under 4000 feet per minute so that proper dilution can be obtained.

Hood exhaust duct runs being added to existing facilities or other mechanical equipment stacks should be run inside the building if at all possible. Any deviation from this guideline would require prior approval and will require special covering or chase construction provisions.

Hood safety systems shall be provided on all hoods. The designer should provide some means of indication to the user that the system is functioning properly. systems shall in general be indicator-type systems that monitor air flow and provide an audible and/or visual alarm if air flow drops below required levels.

Designers are cautioned to evaluate systems for possible hazards that they themselves might introduce (e.g. use of electronic sensors in a flammable atmosphere). In general, the more hazardous the usage of the hood, the higher level of indicator or control system.

In special situations, consideration should be given to integration of the air flow indicator with a variable-speed drive to provide tight control of air flow.

Air flows in hoods must be certified. The air flow quantity of each hood must be tested by an independent testing agency. The results must be certified by the contractor and engineer and submitted to Facilities Planning and Design.

2.8.9 Fire Protection Systems

General Guidelines

Intent
Fire-suppression systems when supplemented by fire alarms and fire-resistant building components, provide the best protection of life and property. As a part of fire-protection systems, suppression systems should be designed taking into account current and future fire-protection needs for the facility. This guideline identifies special considerations for fire-protection systems that are in addition to referenced requirements.

Resources
Resources available to the designer include the following:

DOI Requirements for Automatic Sprinkler Systems
On-campus design professionals

Documentation
Documentation should include details of sprinkler systems, connection to existing systems, and interface with the fire alarm system. For existing buildings which will receive a sprinkler system, the designer shall locate all sprinkler heads, risers, and major equipment. This requirement is due to the extensive use of laboratories and specialized equipment and the desire to have all reviews completed by DOI and IRI prior to the installation of a suppression system. For sprinkler systems added to existing buildings, it may be advantageous to combine the schematic and design development stages. Designers shall indicate by the design development stage if a fire pump is required.

Design Criteria
At a minimum, the following guidelines and standards shall be used in the design of fire-suppression systems. All references are the latest edition unless otherwise note.

Department of Insurance Requirements for Automatic Sprinkler Systems
NFPA 13 Sprinkler Systems
NFPA 14 Standpipe and Hose Systems
NFPA 20 Centrifugal Fire Pumps
NFPA 24 Private Fire Service Mains

The sprinkler system shall be hydraulically design by the project designer unless otherwise stated by agreement. Sprinkler system design for renovations will require the location of heads and lines. This is due to problems with obstructions common to many university buildings. The designer needs to recognize the visual impact of a sprinkler system since some installations will require exposed piping.

Most campus buildings have a fire alarm system which will enable the tie-in of waterflow and supervisory devices.

Water supply data from the closet hydrant must be supplied by the designer. Cost for this should be included in the design contract.

Fire pumps and sprinkler risers should be located in a ground level mechanical room with an outside entrance.

Fire Hydrants
Fire hydrants, when required, shall be cast iron, suitable for a working pressure of 150 psi, and be in accordance with the latest specifications of the AWWA, with two standard nipples and one steamer nipple.

Hydrants shall be constructed in a manner permitting withdrawal of internal working parts without disturbing the barrel or casing valve when shut and should be reasonably tight when upper portion of barrel is broken off. The valve opening shall be at least 4.5 inches in diameter, with the net area of the waterway at its smallest part, with valves wide open, not less than 120% of the valve opening. There should not be chattering under any condition of operation. All fire hydrants must be buried to a depth of 3'6". The direction of the opening should be cast on the head of the hydrant.

Hose nipples shall be bronze or noncorrosive metal, and threads must be City of Pembroke standard. Nipple caps should be securely chained to the barrel.

All hydrants require anchoring with concrete where the water line turns into the hydrant.

Hydrants shall be painted one coat of red primer and two finish coats of City of Pembroke color scheme. Hydrants shall be Mueller "Columbian" or equal.

2.8.10 Equipment Access and Maintainability

General Guidelines

Intent
This section provides guidelines regarding access and maintenance of Equipment. While this area is usually one of the last considered in the Design, it is of the utmost importance, as it affects the daily operation And the ultimate ability of the building to meet its program.

Resources
The primary resource available to designers is the NC Building Code, which List **minimum** access required around equipment. Also, the designer is Encouraged to consult with Facilities Planning and Design operations Personnel to discuss specific needs, and to inspect successful installations.

Documentation
Paths of access to equipment should be shown on the drawings. This Specifically applies to access to chiller tubes and the removal of coils In air handling units.

Design Criteria

General Considerations
Maintenance access to equipment is to be through doors or other approved Permanent openings.

Equipment should be located at grade whenever possible, and when this is not possible, access to it is to be provided via permanent stairs and platforms with approved OSHA railings.

Multiple-story buildings shall provide walk-in access to vertical chases at each floor, and permanent lighting.

Mechanical room access must accommodate removal and replacement of all equipment. The plan should provide for all service operations such as removal and replacement of chillers, fans, coils, tube bundles, etc. Plans will be reviewed carefully to avoid "trapped" equipment , valves, and piping, which will not be accepted.

The designer should allow space for expansion and additions to the equipment, in addition to maintenance access.

Fan coil units are not allowed to be installed above ceilings.

When any equipment is located on the roof that requires maintenance, then stairway access **must** be provided to the rooftop. Access shall not be provided by means of a vertical or a "ships" ladder. Egress onto the the roof must be through a locked door, keyed with the university standard roof key. If additional equipment is to be added to an existing rooftop with only a "ship's ladder" access, then the project shall include construction of new stairs.

Gauges, thermometers, meters, etc., shall be located so that they are readable and accessible from the floor without ladders, mirrors, flashlights, or climbing on equipment and/or pipes.

rotating equipment is not to be mounted above ceilings, in closets or crawl spaces, or in other difficult-to-service locations unless prior approval is secured. If equipment such as fan powered VAV boxes is installed, the access panel should be at ceiling level.

Line-mounted pumps or similar devices shall have motors separately supported when motors weigh more than 25 pounds so that components may be serviced without removing and lowering heavy motors.

Cooling towers and condensing units should typically be mounted on the roof rather than placed at ground level, except when an appropriately designated service court is available. The intent is to reduce noise and clutter at grade and improve options for landscaping and traffic flow.

Submittals and Operating and Maintenance Manuals

Complete technical descriptions of all systems and equipment are needed in written and bound form to support future maintenance, troubleshooting, modifications, and additions. Information normally contained in design documents, submittal data, shop drawings, and maintenance manuals are thus required by the owner for future reference.

At the beginning of construction, the university construction manager will be available to consult with designers concerning submittal data and shop drawings, but will not check them or be responsible for their approval.

At the end of construction, designers are required to furnish to the university three bound and indexed sets of all approved shop drawings, maintenance and operating instructions, parts lists, electrical wiring diagrams, balance data, and manufacturer's literature sufficient for operation and complete maintenance of all equipment by the owner. The designer should review such documents for compliance with these requirements before they are transmitted to the owner. Approved submittals and shop drawings may be included in maintenance manuals instead of being separately furnished if desired.

It is intended that the documentation provided in maintenance manuals, along with as-built drawings, shall be complete and detailed enough to permit and facilitate troubleshooting, engineering analysis, and design work for future changes, without extensive field investigations and testing. Manuals should be prepared to explain system operation and equipment to those not acquainted with the original design.

Manuals shall be durably bound and clearly identified on the front cover and on the spine. Identification should include the building or project name, applicable trade (such as Plumbing, HVAC, etc.), approximately date of completion (month and year), and the contractor's name. If the contract is for an existing building, identification should include any appropriate descriptive terms with the building name such as "Addition to" or "Renovation of."

Manuals shall be organized into well defined and easy-to-locate sections with index tabs or separators to divide the sections. A complete table of contents should be provided at the front, indicating the section or page number for each system, subsystem, or supplier/manufacturer.

Manuals shall include complete information and diagrams on all controls, indicators, sensors, and signal sources. Control diagrams should show the locations of components and major equipment by room number or other identification when room numbers are not applicable. Locations of out-of-sight components, such as duct mounted sensors, flow switches, etc., should be clearly indicated.

Control diagrams must include identification of components by make and model number, operating ranges, recommended set points, reset schedules, and other job-specific data useful for troubleshooting, calibration, and maintenance. Complete narrative descriptions of operating sequences of control systems and subsystems should be included on the prints adjacent to corresponding schematics.

Catalog data and cut sheets should be clearly marked to indicate model numbers, sizes, capacities, operating points, and other characteristics of features provided. Where various sizes or variations of series or model are used, documents should clearly show which are used and where. Where quantities are appropriate, schedules of usage should be provided.

Maintenance literature should include complete information for identifying and ordering replacement parts, such as illustrated parts breakdowns.

Maintenance manuals shall include complete balance data on all systems, where appropriate.

Contractors shall be required to conduct a maintenance and operational instruction session for the owner. Where highly technical or complex equipment is supplied, the manufacturer's representatives, controls subcontractors, and other appropriate personnel who are particularly qualified should conduct training sessions on the campus or job site pertaining to their equipment. Contract documents should require such training to be scheduled with the university in advance.