3.0 DESIGN GUIDELINES

3.1 Introduction

3.1.1 This section contains information to be used by consultants in the design of University facilities.

3.1.2 The criteria represent minimum levels of performance, quality and/or standards, which are sometimes different than those, accepted in private and commercial industry. This is in recognition that these facilities must survive longer than normal service lives, without undue cost to the users and taxpayers, while still supporting academic and research missions of the University of Missouri.

3.1.3. The individual guidelines are grouped under major headings of Architectural, Civil, Structural, Mechanical, and Electrical.

3.1.4. Any conflicts between the requirements in listed reference documents will be resolved by the Project Manager.

3.2 ARCHITECTURAL

3.2.1. General

3.2.1.1 The following information is provided as a guide in establishing architectural requirements and should not be construed to limit the consultant from proposing more cost effective alternates.

3.2.1.2 Facilities will be designed per the latest edition of ADAAG. See section II.D, CodeRequirements.

(1) In all new construction, all public entrances to the building will be accessible to persons with disabilities. The main entrance will be provided with one door, or set of doors, that is power operated. At UMC, if an entrance to the building other than the main entrance is located closer to the parking designated for persons with disabilities, that entrance will also be power operated.

These items should be regarded as a minimum requirement. The design team should evaluate the need for after hours use of the facility which may require accessible entries. If the expected users of the building include a larger than normal percentage of persons with disabilities, other entrances to the building will also be power operated.

(2) In existing structures, a minimum of one entrance will be accessible to persons with disabilities. That entrance will be power operated. The accessible entrance will be either the main entrance or entrance closest to parking designated for persons with disabilities. In existing structures, any design for construction in the vicinity of an entrance should evaluate the possibility of making that entrance accessible. Whenever it is physically and economically feasible, all entrances should be made accessible.

3.2.1.3 The building, addition, or renovation will meet the requirements as defined in SectionII.D, Codes Requirements.

3.2.1.4 Finished floor height will be expressed on contract documents as actual elevation based on University of Missouri's datum, not on an arbitrary one.

3.2.1.5 Design of animal rooms will comply with "Federal Regulations, Title 9, Subchapter A, Animal Welfare 43FR56217" and the Public Health Service Regulations contained in DHEW Publications #(NIH)78-23, and the latest ALAC standards.

3.2.1.6The consultant will plan access for servicing and maintenance of equipment. Minimize rooftop equipment and roof penetrations by consolidating equipment in mechanical penthouses.

3.2.1.7 At some campuses, smoking is permitted only in "Designated Smoking Areas." The consultant will plan space in new construction for this use.

3.2.2 Fire Protection

3.2.2.1 Facilities will be constructed of fire resistant materials.

3.2.2.2 Floors and floor/wall assemblies will at least equal the requirements of the designated User Group, as defined in the latest edition of BOCA National Code.

3.2.2.3 Doors at facility perimeter will have a rating commensurate with the wall system in which they are located.

3.2.2.4 A five-pound ABC multipurpose fire extinguisher (provided by the Owner on UMC projects) will be provided in each laboratory room or area. Emergency showers and eye-washers will be provided as required.

3.2.2.5 Fire extinguisher cabinets will be included in Class A corridors. Cabinets may be recessed or semi-recessed models. Fire hoses will not be provided; however, standpipes and standard two and one half inch (2-1/2") fire department connections are required.

3.2.3 Building Envelope

3.2.3.1 The building envelope will comply with the latest edition of ASHRAE/IES Standard 90.

3.2.3.2 Exterior wall insulation may be semi rigid, blanket batt type, glass fiber, unfaced, complying with ASTM C665 and the following ASTM E84 values:

(1) Flame spread less than 25
(2) Smoke development and fuel contributed less than 50

3.2.3.3 Perimeter foundation walls, walls below grade, and perimeter slab on grade, will be provided with closed-cell, extruded polystyrene insulation board.

3.2.3.4 All foundations walls with accessible or occupied space on one side and soil on the other will be waterproofed below grade.

3.2.3.5 Drain tiles are to be installed at footings and tied to sanitary or storm sewer system as allowed by local municipalities. Down spouts will be tied into storm sewers (in lieu of foundation drain tiles) and will not discharge on grade. Refer to IV.E.2.e. for additional information.

3.2.3.6 Crawl spaces will have concrete floor slabs, floor drains, ventilation and lighting.

3.2.3.7 Exterior building materials will be selected to maintain and/or compliment the harmonious nature of the campus. Care will be given to provide a consistent image to the historical character of the campus. Materials should be practical, maintenance free, durable, and cost effective.

(1) Exterior walls systems of brick veneer over block backup are preferred. The Project Manager must approve the use steel stud backup.

(2) Exterior insulation and finish systems [EIFS] stucco, and plaster will not be used as the primary finish of a building or renovation. The allowed use is for small areas or soffits with the approval of the Project Manager.

(3) The use of curtain walls, spandrel panels, etc.is generally limited to public and vertical circulation areas. The project manager must approve other applications.

3.2.3.8At UMC, door and window frames installed in buildings on the "white campus" will be medium bronze color. Door and window frames installed in buildings on the "red campus" will be cream color. Doors installed in buildings on the "red campus" will be red color. Doors and windows installed in other areas of the campus will be one of the above colors. In existing structures, the color will match the color of the existing windows and/or doors if that color is one of the above. If the color is something other than one of the above colors, the Owner will decide which color to install.

3.2.3.9At UMC, windows installed in areas normally occupied by people will be operable, except in those areas required by code to maintain a specific air balance. Screens will not be supplied with windows.

3.2.3.10At UMC, glazing in windows on the Ared campus@ will have a light bronze tint.

3.2.4 Roofing

3.2.4.1 From the pre-approved systems, the consultant will select roof systems which are suitable for the facility. To evaluate possible systems, the consultant will consider the following design parameters:

(1) Life of the roof system. Preferred systems and associated useful lives include:

Built Up	
Conventional	20 years
Coal Tar	20 years
Single Ply	
Fully-adhered EPDM	15 years
Modified Bitumen (SBS)	20 years
Slate	50 years
Cement/Clay Tile(UMKC)	50 years
Composition shingles	25 years
Metal	
Preformed architectural	

Structural standing seam
Architectural – custom fab

(2) If other systems, such as PVC, TPO, CSPE/Hypalon, mechanically-attached EPDM, APP type modified bitumen are, in the opinion of the consultant, the most appropriate system. It will be evaluated by the project team.
(3) Initial (first) cost of the roof system and additional building costs required for recommended roof system.
(4) Maintenance costs and requirements.
(5) Energy costs associated with recommended roof system.
(6) Building height/roof slope/wind resistance requirements
(7) Present and future use of building, including specific uses in the building that could affect the roof system.
(8) Local environmental issues/contaminants and pollutants
(9) Life expectancy of building
(10) Structural properties of roof superstructure
(11) Type of roof deck
(12) Slope/drainage
(13) Vapor retarder requirements (See VB7-13)
(14) Roof traffic/access and penetrations
(15) Code/Insurance requirements and restrictions
(16) Aesthetics
(17) HVAC internal pressures
(18) Application issues, such as staging, access, building use and occupancy, etc.

3.2.4.2 After establishing design parameters, Systems should be evaluated by the consultant based upon:
(1) Minimum established UM standards (refer to Section IV, Division 4.7)
(2) A choice of roof systems with properties, that, considering all factors, are best suited to the project
(3) Requirements for a total system warrant

3.2.4.3 The consultant will follow these roofing guidelines when designing the roofing system:
(1) Use only recommended roofing systems as identified in Paragraph 4.b above and detailed in Section IV, Division 4.7.
(2) Single-ply ballasted roofs and spray foam roofing system will not be installed.
(3) Light weight concrete will not be used as a means to create slope on new buildings. On re-roofs, it may be used to repair existing decks.
(4) New buildings should have ¼" foot sloope and this should be accomplished by sloping the structure..

(5) If an existing roof has less than ¼" foot slope a serious evaluation will be done to determine if achieving ¼" foot is feasible. If additional slope is required on re-roofs, tapered insulation should be used.

(6) Coal tar roofs shall not exceed 1/8" foot slope.

(7) Use crickets, saddles, and edge strips to deirect water flow away from parapets and penetrations. Backslope is to be confirmed during detailing.

(8) Overflows are required by code. Overflows shall not be piped into the primary roof drain system. Highly visible and dependable systems such as scuppers and "daylighted" drains are preferred.

(9) Provide roof walkways to and around rooftop equipment and other areas as directed by the owner.

(10) At the design development phase, a review should be undertaken by the consultant to include vapor retarder requirements deck type, expansion joint locations and details, salvageability of existing roof insulation, drainage, roof access, roof contaminants, fire rating, and wind uplift factors, and all other applicable parameters.

(11) Existing roof decks will be checked by a registered structural engineer if roof loads are in question.

(12) For re-roof projects, an evaluation will be done by the consultant and the owner to determine if a roof survey by nuclear meter or other means may be performed. Core samples will be taken and results recorded and evaluated.

(13) Roof access will be evaluated, and roof access hatches, ladders and other components will be installed as required by the owner.

(14) Avoid complex flashing details. Minimize use of pitch pans or sealant pockets. Maintain minimum 8" flashing height, 12" is preferred.

(15) Minimize roof penetrations. If structural penetrations are unavoidable, use round or square structural steel shapes to facilitate flashing. Equipment supports for rooftop mounted equipment shall be a minimum 14" height. Use prefabricated equipment supports where possible. Equipment support frames or stands shall provide following working clearances:

Width of Equipment	Height of Legs
Up to 25"	14"
25-37"	18"
37-49"	24"
49-61"	30"
Over 61"	48"

3.2.5 Doors, Windows, Curtain Walls, and Glass

3.2.5.1 All exterior glass systems will be insulated, double pane glass with aluminum thermal break frame construction. No steel framing should be exposed to the exterior.

3.2.5.2 Replacement windows will be aluminum. In restoration projects, wood windows may be allowed.

3.2.5.3 All new construction and major renovations will use low-E glazing. Glazing on window replacement projects will be evaluated on a life cycle cost basis to determine viability of the low-E type.

3.2.5.4Minimum door size shall be 3'0" in width and 7'0" in height.

3.2.6 Finishes

3.2.6.1 Floor Finishes:

(1) Lobby & Public Areas: Hard durable surfaces requiring minimum maintenance such as ceramic tile, slate, quarry tile (non-slip0, marble chip epoxy filled tile, VCT, or Terrazzo.
(2) Classrooms: VCT or sheet vinyl. Carpet will be limited to spaces with programmatic needs such as sound dampening.
(3) Auditoriums & Lecture Halls: VCT, stained sealed concrete, or epoxy in seating areas and carpeting in aisles.
(4) Laboratories: Sheet vinyl, VCT (Dry labs only), epoxy, or sealed concrete based on program requirements.
(5) Offices & Conference Rooms: Carpet. Consider carpet tiles in high traffic areas and as approved by the project manager.
(6) Mechanical Rooms, Janitor closets, storage rooms: Sealed concrete.
(7) Stairwells: Hard surfaced floors with slip resistant covering.
(8) Computer Labs: VCT, carpet, or carpet tile.
(9) Corridors: VCT in classroom and lab buildings. Carpet in office buildings and suites.
(10) Food Preparation & Service: Non-slip Quarry tile or epoxy coating.
(11) Animal quarters: Epoxy coating
(12) Hospital & Clinic application & exam rooms: Sheet vinyl and VCT in procedure rooms.
(13) Restroom: Ceramic floor tile.

3.2.6.2 At UMC, consistently wet areas or wash down areas (such as cage and cart wash areas, kitchens, etc.) should have the following wall system: concrete masonry unit wall with 1/8" fiberglass panel bonded to the wall with mastic and nylon anchors.

3.2.6.3 Water resistant drywall will be used in intermittently wet areas (such as restrooms, wash rooms, custodial closets, etc.).

3.2.6.4 Public stairways in academic buildings should have very durable wall finishes (such as CMU or concrete) and floor finishes.

3.2.6.5 All mechanical rooms will have sealed concrete floors and masonry or concrete walls.

3.2.6.6 Restrooms will have a ceramic tile wainscot with a minimum of 54" in height and will have ceramic tile floors.

3.2.6.7 For high use areas, consideration should be given to the use of modified acrylate copolymer multi-color coating similar to Zolotone or Polomyx.

3.2.6.8 In general, wallcovering should be used only in private offices, conference rooms, or other low traffic areas. Wall covering should not be used in corridors. For conference rooms and similar areas, consider chair rails to prevent wall damage. All wall covering will be commercial grade. Vinyl wall covering will be Type II. Ease of cleaning and serviceability will be criteria for selection

3.2.6.9 Thin coat veneer plaster provides a good durable finish and are particularly useful when matching existing plaster walls.

3.2.6.10

Acoustical wall panels will be used sparingly. The need for a chair rail will be considered and panels will be terminated a minimum of 4" above the finished floor.

3.2.6.11

If carpet is used, consideration should be given to soil hiding characteristics like yarn fiber, color, pattern and yarn density.

3.2.6.12

Avoid mixing floor coverings within one room unless dictated by program needs.

3.2.6.13

Wall and ceiling access doors

(1) Access will be supplied for all concealed valves or other equipment that may require operation or adjustment.
(2) Access doors will have a minimum size of 24" x 24" if possible.
(3) Both mechanical and architectural drawings will note the need for access doors, number of doors needed, and general locations. Exact locations are not desired. Design should require access doors be located to allow access to valves or other equipment.

3.2.6.14

Entry mats, at all main building entrances, roll-up (removable), recessed, floor mats will be installed. At UMC, use linked tread type floor mats. Size and exact location of mats should be of sufficient size to handle foot traffic, but not exceed manufacturer's maximum size recommendation for removal and cleaning.

3.2.7 Furnishings

3.2.7.1 Furnishings such as carpet, wall coverings, furniture and cabinets will comply with "Fire Spread Ratings Requirements" contained in NFPA101 Life Safety Code and other pertinent ANSI standards.

3.2.7.2 Specify prefabricated, stock cabinets, and benches to encourage competitive bidding.
3.2.7.2 Furniture in public areas will be fastened to the structure where justified by safety and/or security concerns.

3.2.7.4 Signs will be installed on the wall adjacent to the latch side of the door whenever possible. If wall space is not available on the latch side of the door, coordinate placement of the sign with the PM. Meet all other requirements of ADAAG when choosing an alternate placement.

Mounting height will be 60" above the finished floor to the centerline of the sign. Mount signs 2" from door trim.

Do not mount signage on or above doors.

At UMC, the consultant should confirm whether signs are to be provided by the campus or specified by the consultant.

3.2.7.5 Preferred standard window treatment is 1" horizontal mini-blinds. These should be bid and budgeted as a part of the construction contract.

3.2.8 Conveying Systems

3.2.8.1 All elevators shall be inspected by state certified inspectors and certified by the State of Missouri before final acceptance.

3.2.8.2 Passenger elevators are preferred to be hydraulic. Hydraulic elevators shall be used for four stories or less. Elevators serving more than four floors shall be electric traction.

3.2.8.3 Where an elevator pit is required, the pit will have a sump pit, a sump pump with an alarm connected to the Building Automation System, and no floor drain.

3.2.8.4 Elevators will be wired and equipped with telephone and supplied with a vandal proof instrument.

3.2.8.5 For each installation, designer will evaluate expected usage of elevator to determine the need for vandalism-resistant construction. At UMC, controls shall always be vandalism-resistant.

3.2.8.6 At UMC, the following shall apply to the Vertical Platform Lifts.

(1) The use of vertical platform lifts is prohibited in new construction. Possible exceptions include access to performing areas in assembly occupancies or to provide access to incidental occupiable spaces and rooms which are not open to the general public and which house no more than five persons.
(2) Lifts may be used in existing facilities built prior to 1991 as part of an accessible route and only when the use of an elevator or ramp is not feasible.
(3) Lifts shall comply with ADAAG and ASME A18.1 – 1999 and Addendum 2.10.1a Safety Standard for Platform Lifts and Stairway Chairlifts.
(4) Lifts shall be installed such that all lift enclosure walls are securely attached to adjacent walls, structure, or supplemental structural supports as required for stability and proper operation of the unit.
(5) The use of vertical lifts is preferred over the use of inclined (stair) lifts.
(6) The lift platform should be fully enclosed whenever possible. The minimum platform size is 36" x 54".
(7) Lifts shall allow unassisted entry, operation, and exit. Operating controls shall be large push-button or paddle controls.
(8) The preferred drive type is recirculating ball screw. The minimum weight capacity is 750 lbs.

3.2.9 Ceiling Systems

3.2.9.1 Provide sound attenuation at partitions and ceilings between major areas. Review criteria for acoustical separation with the PM.

3.2.9.2 Suspended ceiling systems will be designed with a 2' x 4' grid pattern in most areas. Use of a 2' x 2' grid in public corridors, auditoriums, lecture halls, and other areas subject to frequent above ceiling access or upgraded appearance should be considered. Reveal edge tiles may be used in selected areas with approval of the PM. Concealed spline or tongue and groove ceiling systems will not be used.

3.2.9.3 Drywall ceilings should be limited to consistently wet areas (such as cage and cart wash areas, kitchens, biosafety Level 3 or larger facilities) and soffits in special public areas. Access must be maintained to the plenum space.

3.2.10 Telephone and Data Rooms

3.2.10.1

All telephone and data network topology will conform to EIA/TIA Building Telecommunications Wiring Standards.

3.2.10.2 Telephone and data rooms

(1) All telephone and data rooms should not be considered as potential locations for ancillary electrical equipment as well as basic termination of cable/wire/fiber.

(2) Size: minimum size requirements - 5' x 6' with door opening out or 5' x 8' with door opening into the room.

(3) Ceiling height: minimum 8' to ceiling grid or cable distribution system.

(4) Doorways: minimum size requirements - nominal 3' W x 6'-8" H. Must be equipped with a locking door. Handle to have a knurled finish.

(5) Location: minimum of one telephone/data room will be located on each floor. One room should be allocated for every 10,000 gross square feet of floor area. Distance limitations or other considerations may require more than one room. Rooms should be located as close to the core of the structure as possible and should be vertically stacked in multiple story buildings. Average cable runs should not exceed 150' with no single cable run exceeding 295'.

(6) Floor finish: install vinyl composition tile or use a concrete sealer.

3.2.10.3 Telephone and data equipment rooms

(1) Telephone and data equipment rooms are special purpose rooms that serve space and environmental needs of large pieces of telecommunications and data equipment and may not be required in all buildings. The need for these rooms should be discussed with Campus Telecommunications and Campus Computing.

(2) Size: minimum size requirements - 15' x 15' (225 net square feet).

(3) Ceiling height: minimum 8'-6" to ceiling grid or cable distribution system.

(4) Doorways: minimum size requirements - nominal 3'W x 6'-8"H. Must be equipped with a locking door (may be integrated with building security system. Handle to have a knurled finish.

(5) Floor finish: install vinyl composition tile or use a concrete sealer.

(6) Floor loading: minimum 100 lbs/sf equipment load.

3.2.10.4 Construction cost will include installation of telephone/data cabling and Conduit/raceways to the main telephone room and to all outlets.

3.2.11 Janitor Closets

3.2.11.1 Each floor of a building will have a minimum of one custodial closet per 20,000 sf. The main floor closet may be combined with a central storage closet. The closet will be 60-80 sf and rectilinear. Custodial closets will serve that specific use only and will not contain building systems equipment or roof hatches. Furnish with the following:

(1) 24" x 24" floor mounted mop sink with stainless steel edge caps, vandal proof drain, stainless steel splash plates, and a hose connection with a vacuum breaker.
(2) Two duplex electrical outlets (GFCI).
(3) 16 lineal feet of shelving that is 18" deep, 14" between shelves, with the lowest shelf being 20" above the floor. The shelves should be of sturdy construction, capable of holding bulk cleaning supplies with ledge to prevent items from rolling off.
(4) A locking storage cabinet 2'W x 20"D x 6'H.
(5) Ladder and mop/broom hangers mounted on one wall.
(6) Lighting at the 20' candle level. The light fixture(s) shall have safety guards.
(7) A floor drain.

3.2.11.2 Each building will have a central storage closet on the main floor, accessible to the main corridor, and as close as practical to access doors and an elevator. The size of the room will be a minimum of 144 sf. The door will be a minimum of 36" with a storeroom function lockset. The door should open outward if allowed by code. Buildings 50,000 sf and larger should consider an adjacent storage room to accommodate specific storage requirements. Central storage closets will serve that specific use only and will not contain building systems equipment or roof hatches. Furnish with the following:

(1) 24" x 36" floor mounted mop sink with stainless steel edge caps, vandal proof drain, stainless steel splash plates, and a hose connection with a vacuum breaker.
(2) Two duplex electrical outlets (GFCI).
(3) 36 lineal feet of shelving that is 18" deep, 14" between shelves, with the lowest shelf being 20" above the floor. The shelves should be of sturdy construction, capable of holding bulk cleaning supplies.
(4) A locking storage cabinet 2'W x 20"D x 6'H.
(5) Ladder and mop/broom hangers mounted on one wall.
(6) Lighting at the 20' candle level. The light fixture(s) will have safety guards.

(7) A floor drain.
(8) Telecom-data telephone in each

3.2.12 Loading Dock Facilities

3.2.12.1

For new construction and building additions, consultant should review loading dock facility requirements with the PM.

3.2.12.2

Potential needs to be addressed could include:

(1) Trash dumpster/compactor equipment
(2) Recycling containers (paper, cardboard, cans). All buildings will have accommodations for recycling containers and material. Those areas can be alcoves, closets, or rooms suitable for such storage, near a building service entrance or preferably at an exterior covered loading dock.
(3) Truck dock bays (at grade and/or at loading height)
(4) Service vehicle parking (two minimum)
(5) Receiving area
(6) Holding areas (hazardous materials, chemicals)

3.2.13 Restrooms

3.2.13.1

Toilet partitions will be either floor supported-overhead braced or floor and ceiling supported. At UMC only, partitions and screens to be solid polymer plastic resin.

3.2.13.2

Accessible toilet stalls will be designed to meet current requirements of ADAAG.

3.2.13.3

One restroom liquid all purpose soap dispenser will be installed at each washbasin. At UMC, dispensers will be provided and installed by the campus.

3.2.13.4

At UMC, built-in receptacles are not desired. An alcove is preferred to accommodate a freestanding waste can.

3.3 CIVIL

3.3.1 General

3.3.1.1 The following information is provided as a general guideline in establishing civil engineering design requirements.

3.3.1.2 Subsurface Investigations

a. The University will be responsible for providing record location information of the Owner's underground utility lines and structures.
b. The Owner will assist with location of, but will not be responsible for location of, underground facilities owned by public utility, municipal corporation, or other persons.

3.3.1.3 Soils Investigations

a. If investigative soils analysis is required during project design, Owner will retain a soils engineer.
b. The soils engineer, in consultation with the Owner and consultant, will determine number, sizes, depth, and proposed location of borings and/or pits. In general, there will be one boring for every 2,000 square feet of building footprint, with a minimum of four soil borings. To the extent possible, borings should be located near the location of proposed footings/piers.
c. Boring information will be shown, with dimensions, on a plot plan to be submitted in two (2) copies by the consultant to the Owner at least five (5) working days prior to proposed sampling.
d. The plot plan will show:
    (1) A graphic scale, north arrow, and location of existing buildings and trees
    (2) Above and below ground service/utility lines (both utility company and Owner-owned lines)
    (3) Pavement areas and established benchmark(s) with elevation(s) noted
    (4) Existing site features, not specifically mentioned, impacting boring or pit locations.
    (5) The soils/geotechnical report will be included as an informational item of the bidding documents in the general requirements, Division 1.

3.3.1.4 Storm Drainage

a. This section applies to stormwater conveyance systems outside the footprint of buildings. Building systems are covered in Section III.3.5, Mechanical Systems.
b. Trunk storm sewers are defined as the primary spine(s) of the piping system and generally carry the flow from more than one site.
c. Stormwater systems shall be designed using the actual time of concentration. The worst case of complete development, per the current Master Plan, or current conditions shall be used for calculation of offsite flow.

d. Generally the Rational Formula shall be used for areas under 200-acres. Runoff coefficients shall consider percentage of impervious area and average site grade (slope).

e. Return periods will be 25 years with actual time of concentration (duration) for all building sites, pedestrian malls, streets, quadrangles, and Trunk Storm Sewers.

f. Return periods will be ten (10) years with actual time of concentration (duration) for parking lots, park space, and open areas.

g. Project Manager (PM) will establish "return periods" for all other areas.

a. Return period must satisfy governing municipality's regulations.

h. No ponding is allowed on paved areas. Detention basins shall be labeled on the drawings.

i. Designer will compare above return periods with those required by the local municipality. Coordination with municipality may be required and should be reviewed with the PM. Any discrepancies will be discussed with the project manager.

j. All buildings and structures will be developed such that no entry of water through entrances, window wells, area ways, basements, drains, etc. will occur during a minimum hundred year storm. Design should maintain positive drainage away from building entrances.

a. Connections to building drains shall be designed to prevent surcharge from the storm sewer for the 100-year storm.

b. Sidewalk grade shall be set to prevent surface from collecting and channeling surface drainage.

k. Particular attention will be paid to bicycle and wheelchair safety in the design of storm drainage systems. Grate bars will be placed perpendicular to direction of traffic flow. Grates in pedestrian areas should be sized to avoid catching heels of shoes.

l. At UMC, a modified version of the City of Columbia standard curb inlet is used for all work not in the public right-of-way.

m. At UMC only, storm drains, except small area drains, shall be reinforced concrete pipe (RCP) conforming to ASTM C76 or AASHTO M170, Class 3 minimum, and 12” or larger.

n. At UMC only, piping for small area drains in courtyards, small yard areas, and building area ways may be 8” or larger.

o. At UMC only, storm drains less than 36” in diameter shall run on a straight line and grade between structures. Horizontal and vertical bends are permitted in 8” and 10” lines provided a cleanout is included. The deflection should utilize a wye with the cleanout as an upstream extension of the downstream line’s alignment.

p. Consultants shall use the Missouri Department of Natural Resources document “Protecting Water Quality – A field guide to erosion, sediment and storm water best management practices for development sites in Missouri and Kansas” and the EPA guidance “Storm Water Management for Construction Activities” as Best Management Practice guidelines for the preparation of site plans and construction details relative to erosion control on construction sites.

3.3.1.5 Sanitary Sewers

a. Sanitary sewers shall be designed in accordance with the standards and requirements of the Missouri Department of Natural Resources and local requirements (MSD, City of Columbia, Rolla, or Kansas City).
b. Sewer systems shall be designed to carry traffic loads in all locations.
c. Sewer piping installation shall include granular bedding with fines and backfill within the pipe envelope.
d. The minimum service line size shall be 6". The minimum sewer line shall be 8".
e. Sanitary sewer pipe material shall be as described in Section IV, Outline Specifications and Details.
f. Pre-cast concrete manholes shall comply with ASTM C478 or ASTM C76, Class 3. Cast-in-place manholes shall be detailed in the construction documents.
g. Cleanouts may be used at the end of a sewer line where the distance to the downstream manhole is 150-feet or less. Cleanouts are required on service lines outside a building footprint and at horizontal or vertical bends in a service line. The deflection should utilize a wye with the cleanout as an upstream extension of the downstream line's alignment.

3.3.1.6 Site Exterior Equipment

a. Exterior equipment, such as ground mounted transformers, air conditioning units, etc., will be located and landscaped/screened to be aesthetically compatible with surrounding area and adjoining buildings.

3.3.1.7 Roadways, Parking Lots, and Walkways

a. All curbs will be Portland cement concrete.
b. Pavements shall be designed to accommodate the Design Vehicle for the pavements use. The minimum lane width shall be 10-feet, excluding curb and shy distance (concrete pavements), curb and gutter (asphalt pavements), or striping. Curve radii and intersection radii shall accommodate the Design Vehicle's design speed and turning movements.
c. Paved walks less than eight feet wide will be designed with a cross slope of two percent to facilitate drainage. Walks equal to or greater than eight feet wide will have a minimum slope of one percent. It is desired to maintain positive drainage away from walks so surface water does not cross them.
d. All sidewalks will have a minimum width of 7'. Where a sidewalk abuts to a road or driveway, minimum width is 9'. Walks adjacent to roads or driveways will not have grass strips between sidewalk and road or driveway. A medium broom finish will be applied perpendicular to traffic flow. All brooming directions will be shown on the drawings and described in the specifications. Sidewalks abutting a curb line shall be pinned to resist differential movement. Include expansion joint where needed.

e. At UMC, all accessible parking spaces will be "universal spaces." Parking spaces, other than disabled, will typically be 9' in width. No compact car spaces will be permitted.

f. At UMC locations where a parking lot abuts to lawn areas, a mowing strip will be incorporated into the design of the parking lot. A mowing strip is a strip of pavement, 18"-24" in width, on the lawn side of the curb or parking bumpers allowing the lawn to be mowed while parking spaces are occupied.

g. At UMC, accessible ramps adjacent to buildings will have a snow melt system installed, controlled by the Energy Management Control System. At UMC, curb cuts for disabled access will use the campus standard detail. (See standard detail in appendix.)

h. Preferred material for sidewalks, ramps, and other paved, exterior walking surfaces is concrete. All materials must be slip resistive.

3.3.1.8 Water Distribution System

a. All piping shall conform to AWWA standards and the requirements of the MoDNR.

b. UMC Only: All water meters will be located inside buildings. See Section IV, Outline Specifications and Details for information concerning water meters.

c. The preferred material for water distribution systems is C-900, PVC with ductile iron fittings wrapped in plastic. At UMC the Project Manager will provide details.

d. Fire hydrants shall be provided in accordance with the requirements of the local fire district or department. Hydrants shall be provided with an auxiliary valve, installed with the streamer directed toward a street or drive, and with hydrant base flange 6” above finished grade. UMC Project Manager will provide details.

3.3.1.9 Landscape

a. Preservation of existing trees and landscaping will be a primary consideration. At UMC, all landscaping materials, installation, and landscape design is provided by the campus. Grading should be at 6" below finish grade to allow for topsoil placement by the campus.

b. Finished lawn areas will have a finished slope no steeper than one (1) foot vertically to three (3) feet horizontally. Steeper areas will be covered with ground covers or modified with walls or other treatments.

c. Selection of landscape plant materials will be based on plant hardiness and on growth success within the area used.

d. A planting schedule will be provided and timed in relation to planting season and on University's acceptance of the project.

e. Specific treatments will be identified for project limit lines or edges.

f. The following planting schedules will be used:

(1) Spring schedule

(a) Trees (Deciduous and Coniferous Evergreen): Will be planted between March 15 - May 15

(b) Shrubs: same as trees

(c) Ground covers and herbaceous perennials: same as trees

(d) Turf: will be seeded (sodded) between April 1 and May 15

(2) Fall schedule

(a) Trees (Deciduous): will be planted between October 15 and December 15

(b) Trees (Coniferous Evergreen): will be planted between September 1 and October 30

(c) Shrubs: will be planted between September 15 and December 15

(d) Ground covers and Herbaceous Perennials: will be planted between September 15 and October 15

(e) Turf: will be seeded between August 25 and October 1; will be sodded between September 1 and November 15

3.4 STRUCTURAL

3.4.1 General

a. The following information is provided as a guide for designing structural support systems. All load criteria will be in accordance with the latest edition of BOCA.
b. Load criteria for all structural systems will be noted on the drawings.
c. Separate additions from existing structures with an expansion joint.
d. Do not transfer vertical loads through horizontal expansion joints.
e. Gypsum roof decking will not be used. Preferred roof decking material is steel or concrete.
f. All roof decks will be designed with a minimum slope of 1/4" per foot. Positive slope for drainage will be provided by the roof deck rather than tapered insulation (except at crickets and around equipment pads).

3.4.2 Foundations

a. Subsurface design requirements will be based on a current geotechnical investigation from which soil profiles, design parameters, compaction requirements, and foundation design options are established.
b. In instances where concrete duct banks, steam tunnels, and other concrete masses join foundations walls, steel pins for reinforcing steel anchoring will be attached to the foundation walls through use of epoxy capsules similar in material and quality to those supplied by Hilti. Other penetration requirements are found in V.B.15.I.B and V.B.16.I.A.
c. Penetrations of foundation walls by direct burial cable and/or small diameter penetrations shall be sleeved or core drilled, and shall be sealed through the use of 3M Scotchcase 2114, or equal sealant.

3.4.3 Floor Loading

a. Floor loadings will be increased as required to meet equipment loadings and conditions specified by equipment manufacturer.
b. If live load reduction is used, it will be in accordance with the latest edition of BOCA and must be noted on the drawings.

3.4.4 Roof Loadings

a. Minimum roof load design will comply with live load or snow load, whichever is greater.
b. Roof service loading will be increased as required for external equipment, ducting, and supported utility requirements.

3.4.5 Wind Design

a. Every building and structure will be designed and constructed to resist prescribed wind effects. Wind will be assumed to come from any horizontal direction. Wind effects will be analyzed in at least two mutually perpendicular horizontal planes.

b. Exposure category "B" will be used for all campuses.

3.4.6 Precast Concrete Design Criteria

a. The architect will specify allowable deflections to be used in the design of the panels to maintain integrity of the panel.
b. Panels will be designed with adequate structural integrity to permit handling, transportation, storage, and erection.
c. Waterproofing materials are discouraged on new concrete surfaces.

3.4.7. Masonry

a. Design and construction guidelines and technical notes of the Brick Institute of America (BIA) will be followed for brick and the Masonry Advisory Council (MAC) for concrete masonry unit (CMU) construction.
b. Use of stone coping for modification to existing facilities with stone coping will be allowed. Use of stone coping for design effect will require specific approval from the PM.
c. Masonry units will not be used for foundations walls below grade.
d. Waterproofing materials are discouraged on new masonry, or stone surfaces. Use will require project manager approval.
e. The designer will evaluate the expected movement for each wall and require adequate expansion joints to accommodate the movement.

3.5 MECHANICAL SYSTEMS

3.5.1 General Mechanical Guidelines

3.5.1.1 General Design

(1) Heating and cooling system loads for the purpose of sizing systems and equipment will be determined in accordance with procedures described in the latest edition ASHRAE Handbook, Fundamentals.

(2) Indoor design temperature and humidity conditions for general comfort applications will be in accordance with the comfort criteria established in the latest edition of ANSI/ASHRAE Standard 55, Thermal Environmental Conditions for Human Occupancy or Chapter 8 of ASHRAE Fundamentals Handbook.

(3) Outdoor design conditions will be selected from the latest edition of ASHRAE Fundamentals Handbook, or from data obtained from the National Climate Center or similar recognized weather source.
   (a) Heating design temperature will be no lower than the 99% dry-bulb.
   (b) Cooling design temperature will be 95°db, 78°wb and for cooling towers 80°wb.

(4) Winter humidification and summer dehumidification are not required in general comfort applications.

(5) Ventilation systems will be designed to provide outdoor air ventilation rates in accordance with section 6.1.3 of the latest edition of ANSI/ASHRAE Standard 62.

(6) Supply/return air systems will be designed in accordance with the latest edition of ASHRAE Fundamentals Handbook.

(7) Piping systems will be designed in accordance with the latest edition of ASHRAE Fundamentals Handbook.

(8) HVAC equipment will have a minimum efficiency at the specified rating condition, not less than the values shown in ASHRAE 90.
   (a) Compliance with minimum efficiency requirement specified for HVAC equipment will include compliance with Integrated Part-Load Value (IPLV) as well as standard or full-load requirements.

(9) UMC, UMKC, UMR Only: steam and chilled water are preferred systems.

(10) All penetrations through firewalls, or floor or roof decks will have firestopping material installed at the penetrations and will be shown on the drawings.

3.5.1.2 Piping general:

(1) UMC Only: campus water distribution system operates at 70-80 psi, which may create the need for pressure reducing stations or other special considerations for specific applications.

(2) Butterfly valves for all water systems shall use aluminum bronze, EPDM coated, or stainless steel disks. Nickel-plated disks are not allowed.

3.5.1.3 Equipment

(1) Major equipment will be provided with adequate pressure, temperature, and flow indicators at time of installation to establish unit performance.

(2) Equipment will be provided with bearings lubricated for life by the manufacturer or built in automatic lubrication system where possible. Where periodic lubrication is needed, specification will require lubrication points to be readily accessible for lubrication.

(3) Electric heating systems will not be used.

(4) Access doors will be provided to coils, filters, motors, belts etc.

(5) Vibration and sound transmission from mechanical equipment will not exceed ASHRAE sound criteria.

(6) All HVAC equipment will be located to facilitate accessibility, maintainability and replacement.

(7) All coils within air handling units, chillers, and heat exchangers will be capable of being pulled without obstruction of equipment, pipes, conduit, etc., or requiring removal of any other coil in the same unit.

(8) All mechanical equipment/systems will be installed on a 4" minimum concrete housekeeping pad, and where required, steel support framing as required to allow proper housekeeping, drainage, and access.

(9) Where exterior equipment is to be located above a roofing, system adequate space will be provided below equipment to allow for roof maintenance as specified by NRCA Roofing Manual. Avoid multiple roof top penetrations.

(10) All motors will be high efficiency.

(11) No motors will be designed to operate in the service factor.

(12) Motors will be designed to operate continuously at all speeds with variable speed drives having carrier frequency of 12 KHZ or higher without large fluctuations in amps drawn at any single speed.

(13) Equipment pits, whenever possible, will be drained by gravity to storm or sanitary lines (local authority approval). Where gravity drainage is not possible, a sump with a pump will be installed. The sump will have an alarm installed, connected to the building automation system whenever possible, to alert maintenance personnel whenever the water level rises and before the water overflows the pit. Where the building automation system is not available, a local alarm will be installed.

(14) UMC Only: The campus steam system exits the power plant at 62 psig and 420 degrees F. The system operates at 55 to 62 psig and from 300 to 420 degrees F. All equipment using the steam must be able to handle the site pressure and temperature. The Owner will verify the pressure and temperature of the steam for each installation. At a minimum any equipment installed on the

system must be able to handle 400 degree F. steam at a minimum pressure of 55 psig at the building entrance.

(15) UMC Only: The campus pumped condensate system operates with a pressure that varies from 25 to 60 psig. The Owner will verify the condensate system pressure for each installation.

(16) UMC Only: All condensate pumps must be capable of handling high temperature condensate (210 degrees F.).

(17) UMC Only: Condensate tanks must be sized at a minimum of three times the calculated peak flow in gpm.

(18) UMC Only: A pressure gauge is to be installed on the system side of the condensate pump discharge check valve.

(19) UMC Only: Pressure powered pumps shall be used.

3.5.1.4 Insulation

(1) All insulation will comply with ASHRAE 90.1. UMC Only: comply with Energy Management Office (EMO) insulation standard.

(2) Insulation containing asbestos is prohibited. All new insulation shall be marked "Asbestos Free" or "Non-Asbestos Insulation".

(3) All plumbing systems will be insulated: domestic cold and hot water supply, hot water return lines, horizontal storm drain lines and roof drain sumps, and exposed waste lines.

(4) Provide insulation on equipment, pipes, and ducts where:

(a) Heat transmitted will significantly affect ambient temperatures in controlled spaces.

(b) Heating or cooling effects will be significantly affected due to heat flow into or out of pipes or ducts.

(c) Condensation will occur as a result of surface temperature approaching dew point of the ambient air.

(d) Significant energy loss would result from heat transfer.

(e) Personal injury may result (external surface temperature is 150^{o}F or greater).

3.5.2 Building Plumbing Systems

3.5.2.1 General guidelines

(1) Access doors

(a) Access doors will be supplied and sized for all concealed valves or other equipment that may require operation or adjustment.

(b) The access doors will have a minimum size of 24" x 24" if possible.

(c) Both the mechanical and architectural drawings will note the need for access doors, the number of doors needed, and the general locations.

(2) Plumbing Fixtures

(a) Locations of electric water coolers and fixtures with automatic flush valves (battery), with courtesy flush button [UMC only], will be noted on electrical and plumbing plans. All plumbing fixtures will be noted on the architectural drawings.

(3) Metering

(a) UMC Only:

i) Energy Management Office (EMO) provides water meter specifications. The designer should coordinate sizing of meters with that office. The contractor will be responsible for installation of meter.

(b) UMR, & UMKC Only:

i) The domestic water line entering a building will be metered. Meter units will be totalized in 100 cubic feet increments, Rockwell series W turbo meter.

ii) The steam condensate line exiting a building will be metered. Metered units will be totalized in 1,000 pound increments.

iii) Chilled water lines in a building will be metered indicating flow in gallons per minute.

iv) Hot water heating supply line serving the building will be metered if the heat source serves more than one building. Meter will totalize BTU's consumed by the building.

v) Chilled water supplied from an outside distribution system will be metered. Meter will totalize BTU's consumed by the building.

(4) UMC Only: A water sampling tap will be installed on all water mains upon entering the building. Tap will consist of a 1" tap with a ball valve installed at the 12 o'clock position. Two 90E elbows will be installed to direct water flow toward the floor, similar to a faucet. Locate tap so discharge outlet is a minimum of 12" above the floor. Do not locate tap in any pit below main floor level. See standard detail.

3.5.2.2 Domestic water systems (above ground)

(1) Hot water systems

(a) Domestic water heating systems will be designed in accordance with Chapter 54 ASHRAE Handbook, HVAC System and Applications.

(b) All water heaters and hot water storage tanks will meet efficiencies set forth in the latest edition of ASHRAE/IES Standard 90.

(c) Availability of existing hot water source and cost effectiveness of its use will be investigated while designing a domestic hot water system for the specific project. UMC, UMR, and UMKC: Steam is the preferred heat source for all hot water systems.

(d) UMC Only: Program requirements for hot water will be evaluated to determine whether a code variance to eliminate hot water is desirable.

(e) Desired temperature for hot water is a maximum of 110°F at the point of usage for normal faucet applications. Other types of usage may require other

temperatures (dishwashers, cage washers, etc.) and should be evaluated individually. Where temperatures higher than 110°F are required at certain outlets for a particular intended use, separate heaters or booster heaters will be installed for those outlets.

(f) Where rapid fouling due to heavily mineralized water is anticipated, heated water will be outside the tube.

(g) Instantaneous, tankless water heating systems are preferred whenever feasible.

(h) Recirculating pumps in hot water systems will be constructed of non-ferrous material.

(i) Expansion tanks

i) Allowing the pressure relief valve to dump excess water due to expansion is not acceptable.

ii) All expansion tanks will be installed with provisions for draining and venting, and will have a sight glass.

iii) All hot water systems with backflow preventers will be designed and installed with the most efficient and cost-effective method of thermal expansion.

(2) Water softeners

(a) Water softeners will be plumbed to domestic hot water systems.

(b) UMC Only: Water softening is required on all central hot water systems larger than 200 gallons. Other water will not be softened except for specific applications requiring softened water.

(c) All water softening equipment will be installed with a test port immediately downstream from the softening equipment.

(d) Water softening systems should be designed to supply water at less than 1 grain of hardness. UMC Only: water supply typically has 13.5 grains of hardness.

(3) Water coolers

(a) All water coolers will be refrigerated type.

(4) Hose bibbs and wall hydrants

(a) A hose connection will be installed in each mechanical room.

(b) Hose connections will be located on the exterior of each building. A minimum of one hose connection will be installed on each side of the building. Preferred spacing for hose connections is one every 100'. Were feasible, hose connections should be installed within 15' of the main entrance to the building.

(c) All exterior hose connections will be of the recessed socket type.

(5) Backflow preventers

(a) All domestic water systems will have backflow prevention devices at the point of building entry. No metering devices, taps, or other fittings will be located upstream of the backflow preventer. However, if a common supply serves both the domestic water system and the fire protection system, it is preferred the two systems be split immediately upon entering the building. Install the backflow preventer for each system at this point. For critical locations, install two (2) backflow preventers each at 60% capacity.

(b) All backflow preventers will be located and configured to allow ready accessibility for maintenance and testing. Minimum clearance is 24" in all directions.

(c) No backflow preventers will be located more than 4' above floor level.

(d) Pit installations of backflow preventers will not be allowed.

(e) Drainage from backflow preventers must be possible by gravity only, either to a floor drain or to surface of the ground.

(6) Insulation

(a) All domestic water systems will be insulated with fiberglass insulation.

3.5.2.3 Sanitary waste and vent

(1) All sanitary waste systems will be designed for a maximum of 140EF material. No material will be dumped in any sanitary waste system having a temperature of more than $140^{E}F$. In some cases this will require cooling units on waste discharge. If equipment such as a dishwasher is installed that may discharge at slightly higher temperatures, PVC piping may not be used until discharge has cooled to $140^{E}F$ or less.

(2) Every piece of equipment requiring indirect waste (backflow preventers, ice machines, autoclaves, etc.) will be served by a drain at that piece of equipment. More than one piece of equipment can be served by a drain provided pieces of equipment are close to each other and sizing of the drain provides adequate drainage for the equipment. The preferred method for supplying this drain is by use of a floor drain, but other types of drains are acceptable, depending on the individual situation. In no case will drainage be accomplished by installing piping across the floor to a central floor drain.

(3) Floor drains

(a) All mechanical rooms will have a minimum of one floor drain. More floor drains will be installed as required to maintain a ratio of one floor drain for every 500 square feet of floor area. These floor drains are in addition to those drains required for equipment.

(b) Floor drains will be designed to drain the floor around them by the force of gravity. Specify in specifications that each floor drain will be tested to ensure that water on the floor in the area served by the drain is able to reach the drain by the force of gravity alone.

3.5.2.4 Storm sewer systems

(1) All surface water will be directed to a storm sewer system. In no case will storm water be placed in a sanitary sewer system.

(2) Surface discharge of storm water will not be allowed.
(3) All interior piping of storm water will be insulated.

3.5.2.5 Foundation drainage systems

(1) Required for all buildings with usable space below grade.
(2) Minimum schedule 40 perforated PVC or SDR 35 with a 12" surround of 1" clean rock and geotextile filter fabric wrapper, below an 8" vertical plane of 1" clean rock from pipe to 3' below finish grade. An in-plane geotextile drainage board is also acceptable.

3.5.2.6 Special systems

(1) Emergency showers and eyewashes
    (a) Floor drains will not be installed in close proximity to emergency showers and eyewashes.
    (b) All piping to emergency showers and eyewashes will comply with ANSI Z358.1.
    (c) UMC Only: In new construction, any situation requiring either an emergency shower or eyewash should have both installed. It is preferred that they be co-located. Drainage for showers and eye washers will be onto the floor (no floor drain), unless directed otherwise by project manager (PM).
    (d) UMC Only: All emergency showers will have a local alarm to notify persons in the area that the shower is in use.
    (e) Designs for installations of emergency showers or eyewashes should consider the feasibility of providing an alarm connection to the building security system.

3.5.2.7 Fixtures

(1) Custodian closets
    (a) Each custodian closet will be supplied with a floor sink. UMC Only: preferred size is 24" x 36" and minimum size is 24" x 24". Sink will be supplied with a stainless steel edge cap.
    (b) Splash plates will be installed on the wall around the floor sink.
    (c) Faucet will be equipped with a hose connection, brace, and vacuum breaker.
(2) Plumbing fixtures
    (a) All water flow control devices will be of the water conserving type.
    (b) In new construction, all fixtures will be wall-hung. In existing construction, wall-hung fixtures are preferred if feasible.

(c) New Buildings and major renovations shall have a minimum of one (1) floor mounted urinal installed in an accessible men's' stall and women's' stall. The preference is to locate these facilities on the main floor near assembly occupancies, but other floors may be acceptable. These fixtures do not count towards the overall fixture count. Consideration may be given to using an accessible unisex restroom if approved by the Project Manager.

3.5.3 Underground Piping Systems

3.5.3.1 General requirements

(1) Under building slabs the engineer will evaluate the expected load and specify appropriate materials to carry the load.
(2) Using a standard proctor at optimum moisture content (-2% to +4%), all backfill will be mechanically compacted in maximum lifts of 12 inches to a minimum of 95% of maximum density.
(3) Underground piping systems containing asbestos are prohibited.

3.5.3.2 Foundation drainage systems

(1) Clean outs
  (a) Provide at no more than 100' on center for straight runs of pipe.
  (b) Provide downstream of each elbow, within 12" of the elbow.
  (c) Supply with brass plugs.
(2) Connect to the sanitary sewer or storm sewer system, as required by local municipality, or as directed by the Project Manager.

3.5.3.3 Water distribution systems

(1) All piping systems will comply with AWWA standards.
(2) UMC Only: All water meters will be located inside buildings. See Section IV, Outline Specifications and Details for more information about water meters.
(3) Valves will be installed with cast iron valve boxes, set in a concrete surround that is a minimum of 12" x 12" x 4" thick. Cover to the valve box will be marked "Water."
(4) Preferred material for water distribution systems is PVC.

3.5.4 Fire Protection Systems

3.5.4.1 Sprinkler systems

(1) All new buildings will be designed with automatic fire protection systems throughout the building. Wet pipe type system is preferred.
(2) Materials and equipment will be approved, listed, and labeled by UL or FM specifically for fire protection service. System will be designed in accordance with NFPA for the application intended.
(3) Fire protection systems will be installed per NFPA.

(4) Sprinkler shop drawings will include hydraulic calculations.

(5) All test valves will be located in mechanical rooms in central locations with easy access. A minimum number of locations will be used for test valves. In new construction it is preferred all test valves be at one location.

(6) A pressure gauge will be installed on the main supply of each sprinkler system, upstream from the main test valve.

(7) Drainage will be provided for all test locations that is sufficient to carry the full flow of water that can be expected during testing of the systems. This is particularly important at the location for testing the main drain of a system. Directing test water to exterior of the building is not acceptable.

(8) Exterior fire fighting water connections will be sized according to requirements of the local fire district.

(9) All sprinkler systems will have an addressable fire alarm panel installed capable of monitoring and reporting flow in all zones and tampering with all valves of the system. Panel will be equipped for sounding a local alarm and will be capable of interface with the campus security system. UMC Only: If campus security system is in place in the building, the fire alarm panel will be connected to that system.

(10) Where a sprinkler system is to be installed in a non-heated area, it is preferred a dry pipe system be installed rather than a chemical system.

(11) All sprinkler systems will have a double check type backflow preventer installed at the point of building entry.

3.5.5 Refrigerant Cooling Systems

3.5.5.1 General design guidelines

(1) UMC Only: All refrigerant systems will comply with Energy Management Office (EMO) Energy Conservation Policies.

(2) All mechanical room installations will comply with ASHRAE 15.

(3) Waste water cooled units are not acceptable.

(4) All roof mounted condensing units will be designed to 1151F outside air temperature.

3.5.5.2 Material

(1) All valves will be full port. Provide isolation valves on each side of driers. Provide check valves on the discharge of compressors. Discharge from all relief valves will be piped to exterior of the building.

(2) Insulate suction and hot gas bypass in all locations and discharge lines if exposed in occupied areas. For units above 5 tons, use 1" fiberglass insulation. For smaller units, use 1/2" closed cell foam insulation, minimum. All insulation on exterior piping will be protected by an aluminum jacket.

3.5.6 Water Cooling Systems

3.5.6.1 General requirements

(1) Chilled water will be provided by:
  (a) Making use of existing chilled water distribution system and existing chiller;
  (b) Providing new chiller, but using the existing distribution system as much as possible; or
  (c) Providing new chiller with new chilled water distribution system.
  (d) UMC Only: Coordinate with EMO prior to beginning design.

(2) All new chilled water systems will be Primary/Secondary systems with 2-way control valves. The secondary systems will have variable speed pumps and 2-way control valves.

(3) Condensing water systems will be equipped with automatically controlled water treatment and blowdown systems designed to control scale buildup, corrosion, and concentration of dissolved solids.

3.5.6.2 Chilled water loops

(1) All chilled water loops will be two pipe systems. UMR Only: Single pipe chilled water loop system.

3.5.6.3 Equipment

(1) UMC Only: Selection of all equipment will comply with the MU Energy Conservation Policy. Request policy from Project Manager.

(2) Chillers
  (a) UMC Only: The type of chiller to be installed will be determined by the EMO for chillers larger than 100 tons.

(3) Water treatment
  (a) UMC Only: Designer will coordinate design of water treatment system with EMO.

3.5.7 Steam and Hot Water HVAC Systems

3.5.7.1 General

(1) Heating system will be equipped with treatment system designed to control scale buildup and corrosion, and boiler blowdown control. Condensate treatment will be included where applicable.

3.5.7.2 Steam Distribution.

(1) UMC Only: Direct buried systems are not allowed. All distribution piping will be installed in a steam chase.

3.5.7.3 Medium and low pressure steam (above grade)

(1) Medium pressure steam is defined as having 15-60 PSI. Low pressure steam is below 15 PSI.
(2) All drawings will show drip legs and specifications will require drip legs for all risers.
(3) Pressure Reducing Valves (PRV)
    (a) All PRVs will be installed with isolation valves, a bypass loop with a globe valve in the bypass, and pressure gauges on both sides of the PRV. All PRVs will be located and configured to allow ready accessibility for maintenance. Whenever possible, provide a minimum clearance of 24" in all directions. No PRV will be located more than 8' above floor level. Designer will evaluate the feasibility of using wall-mounted PRVs.
(4) UMC Only: Building systems (AHU, HX) will be designed for a maximum operating pressure of 15 psig. Sizing of control valves, PRV, traps, etc., will be based on a delivery pressure setting of 5-7 psig.

3.5.7.4 Hot water

(1) Pumps
    (a) All pumps will be installed in easily accessible locations and will have isolation valves installed on each side of the pump.
    (b) All pumps will have mechanical seals.
    (c) Base mounted, centrifugal pumps will be installed with a pressure gauge manifold and a suction diffuser/strainer. Pipe vibration isolators will be stainless steel. Designer will evaluate the need for vibration isolation on the pump.
(2) Air venting
    (a) Automatic air vents are not preferred. If used, they must be readily accessible.
    (b) Hose bibbs will be installed for manual air vents at all high points of the hot water systems.
    (c) Air separators are required on all systems. Centrifugal type air separators are preferred.

3.5.8 Air Handling Systems

3.5.8.1 General requirements

(1) Variable Air Volume (VAV) systems are preferred.
(2) Economizer cycles are preferred but should be evaluated on a cost/benefit basis. If an economizer cycle is used, a return air fan is suggested to prevent over pressurization of the conditioned space.
(3) All systems using 100% outside air should be evaluated for use of heat recovery systems.
(4) Pitot tube test port stations will be provided in all locations as required to determine fan system or zone air volumes.
(5) Air handling units will consist of factory fabricated components.

(6) A drawing will be mounted near the air handling unit showing as-built locations of all fire dampers, balancing dampers, VAV boxes, coils, and other equipment in the ductwork served by that unit. The drawing will be protected by glass or other suitable material.

(7) Large systems are preferred over small multiple systems.

(8) The location of outside air intakes will be carefully considered to prevent intake of exhaust from other systems, equipment or parking areas. Where possible, intakes should not be located at or below ground level to minimize maintenance problems from leaves and grass clippings.

3.5.8.2 Air handling units

(1) Air handling unit sections will be factory fabricated. Desired air handling unit features include:
   (a) Full-sized access sections between all coil and filter sections. Access sections will have an electric light;
   (b) Hinged access doors will be provided on all units to provide access to filters, coils, fans, dampers, etc. Door handles will be used on these doors. Bolted panels are not acceptable except on very small units.
   (c) Side loading or upstream loading filter banks.

(2) Exterior units will be designed specifically for outdoor installation. All piping will be within the unit enclosure.

(3) For new construction, and existing buildings where possible, locate all air handling units inside the building or in a penthouse. Rooftop and above ceiling locations are not preferred. VAV boxes should be located in corridors or other common areas whenever possible.

(4) All units will provide thorough mixing of outside and return air. Blow-through units are preferred over draw-through units for 100% outside air units. Designer will evaluate the need for engineered mixing boxes, blenders, or other methods to prevent stratification of the air.

(5) Sufficient space will be maintained between heating and cooling coils so air stratification is eliminated.

(6) Filters will comply with ASHRAE Systems and Equipment Handbook, Chapter 25, Table 2.

3.5.8.3 Fans

(1) Fans will be selected to provide highest efficiency and lowest noise characteristics practical while meeting specific system requirements. Recommended level is 85db, five (5) feet from the unit.

(2) Fan type and characteristics will be selected to assure stable nonpulsing performance in required operating ranges. Air foil fan wheels are preferred.

(3) Variable speed drives will be considered for fans having 5 HP or larger motors.

(4) Fan motors up to 15 HP, fans with belt drives will be provided with adjustable pulley sheaves. Midpoint of adjustment will be at design condition.

(5) Fans with motors larger than 15 HP, fixed non-adjustable drives in which motor pulleys of different diameter can be used, will be provided.

(6) The motor selected will have adequate fan/impeller inertia capacity and torque capability to bring the fan to full operating speed in less than 20 seconds. Appropriate starting devices and overload relays to tolerate this time period will be selected.

(7) Fans will comply with AMCA Standard 210 and ASHRAE Standard 51.

3.5.8.4 Coils

(1) Coils will be certified by ARI STD. 410.

3.5.8.5 Filters

(1) Filters will comply with ASHRAE.

(2) Final filter efficiency is a minimum of 60% or per ASHRAE, which ever is more stringent.

3.5.8.5 Dampers

(1) Outdoor air intake dampers will conform to AMCA Standard 500. The air leakage rating across the damper when closed will not exceed 6 cfm/sq.ft. at 4" water column static pressure differential.

(2) Volume dampers will be opposed blade.

(3) All balancing dampers will lock in position.

(4) Position of all dampers will be marked on the shaft of the damper by use of a groove or saw kerf.

(5) Fire dampers will be in accordance with NFPA 90A and with a UL approved fusible link.

3.5.8.6 Ductwork

(1) All main and branch ductwork will be constructed of galvanized sheet metal per SMACNA. Construction will include the use of duct sealant.

(2) Fabrication and installation of the turning vanes will conform to latest SMACNA Standards.

(3) Maximum leakage for all duct systems is 3%. All ducts will be tested per SMACNA.

(4) All branch duct takeoffs will use the 45 degree design and will have a balancing damper installed in each branch as close to the main duct as practical. No splitter dampers or air extractors will be used.

(5) Only external insulation will be used. Insulation containing asbestos is prohibited. In mechanical rooms or other places where ductwork is exposed, rigid fiberglass insulation will be used. Rigid fiberglass insulation will be a minimum of 2" thick and will be glued and pinned.

(6) Flexible ductwork will have a maximum length of 6' and will be properly supported. Provide a typical support detail on the drawings. Flexible ductwork will only be used

for connecting the branch duct to the diffuser. In no case will flexible ductwork be used upstream of VAV boxes.

(7) Use of Ductliner will be minimal and primarily for sound attenuation.

3.5.8.7 Diffusers

(1) Diffusers with integral dampers will not be used.
(2) Perforated diffusers will not be used.
(3) In a suspended ceiling installation, it is preferred diffusers use a 24" x 24" mounting plate. A small diffuser mounted in a large ceiling tile is not acceptable.
(4) Diffusers for VAV systems will be specified with consideration given to air dumping at low velocities.

3.5.8.8 All turning vanes will be airfoil type.

3.5.8.9 Fume hoods and laboratory systems

(1) General requirements
  (a) All systems, whether new or replacement, will be designed using VAV hoods and constant volume exhaust fans with plenum boxes and barometric dampers. If the complete exhaust-supply system cannot be installed at time of fume hood installation, at a minimum, VAV controllers for the new equipment will be installed. This may require a constant velocity type fume hood be installed. If so, select the fume hood for future modification to a VAV type fume hood. Minor modifications to existing fume hoods not increasing makeup air problems or cause other imbalances are exempt from this requirement.
  (b) All fume hood systems will be designed according to ANSI Z9.5. UMC Only: Design face velocity will be 100 FPM at full sash.
  (c) Perchloric and radioactive systems will be completely separate from other exhaust systems.
  (d) VAV systems (supply, return, and hoods) are required. Constant volume exhaust fans are preferred.
  (e) Exhaust systems will be designed in accordance with the latest edition of the Industrial Ventilation Manual by the American Conference of Government Industrial Hygienist.
  (f) For all fume hood installations or alterations, the balance of make-up air to exhaust air for the affected zone or building will be evaluated. Fume hoods that will cause or aggravate an imbalance between the make-up air and exhaust air will not be installed unless the imbalance is corrected. The preliminary design for a project may proceed on the basis of existing drawings and/or balance data. The final design must be based on actual test data.
  (g) Manifold central exhaust systems are preferred over individual exhaust systems where feasible.

(h) Supply air diffusers will not be located in front of a fume hood. Design per ASHRAE guidelines.

(i) Fume hood shall be located out of traffic ways, preferably in corners with one foot from the perpendicular wall.

(2) Fume hoods

(a) All fume hoods will be equipped with a face velocity monitor and markings on the front of the hood indicating maximum sash opening height and sash height for maximum air flow.

(b) UMC Only: All fume hoods must be certified by MU Environmental Health and Safety before use.

(c) UMC Only: All fume hoods will have half-sash locks with alarms. Alarms may have a user override but, if the override is used, will alarm again after four minutes.

(d) All fume hoods will have flow indicators with low flow alarms.

(e) UMC Only: Vertical sashes are preferred. The use of horizontal sashes is discouraged.

(3) Ductwork

(a) All fume hood and laboratory exhaust system ductwork will be constructed with 304 stainless steel and will be of welded construction unless other materials are required by the uses of a particular system.

(b) Exhaust ductwork through occupied areas will be under negative pressure and exhaust fans will be located on the roof.

(4) Controls

(a) Control fume hood exhaust, room exhaust, and room supply airflows with a VAV scheme to maintain a constant fume hood face velocity of 100 FPM and to provide climate comfort control for the room occupants.

(b) UMC Only: Control equipment will be Phoenix, Tech Air or approved equal. Airflow control devices will be venturi type valves.

(c) Any control system used will have a response time of 1 second or less.

(d) Use a proximity sensor to reduce face velocity to 70-80 FPM when no one is in the immediate vicinity of the front of the fume hood.

(e) Use sash position type of control design, not air pressure differential.

3.5.8.10 Animal Quarters

(1) Design parameters for animal quarters will include 100% outside air, 100% exhaust, heat recovery on exhaust air, and a 50% safety factor on total heat load.

(2) Verify required space temperatures with ultimate user of the space.

(3) Where available, use steam for all preheat coils. Use a freeze-proof design on all coils.

3.5.811 Auditoriums

(1) Design of air handling systems for auditoriums should consider use of CO_2 monitors and occupancy monitors to control the amount of outside air required.

(2) Generally it is preferred auditorium systems be separate from other building systems.

(3) Submit acoustic calculations for mechanical equipment. Particular attention will be given to low frequency vibrations.

3.5.9 Control Systems

3.5.9.1 General requirements

(1) UMC Only: All control systems will comply with Energy Management Office (EMO) Energy Conservation Policy #040 located in Appendix G-2.

(2) All mechanical equipment is to be tied into the campus central control system.

(3) All DDC system equipment and protocol will be BACNet compatible.

(4) Design will include a complete sequence of operation, schematic, and point listing of all mechanical control systems on the design drawings.

(5) System alarms/messages will be indicated through the control system when applicable and specifically indicated in the controls sequence.

(6) The following control features will be incorporated into the sequence of operation where applicable and justified.

(a) Operational Schedules
(b) Economizer Cycle
(c) Demand Control
(d) Temperature Reset
(e) Variable Air Quantities (supply/exhaust)
(f) Fan Speed Control
(g) Deadband Control

(7) Use of pneumatic actuators with electronic sensors and controls is preferred. If electric actuators are used, they will be industrial and/or heavy duty.

(8) All safeties, including freeze-stats, smoke detectors, high static detectors, outside air EPs, etc. will be hard wired in series with the motor controllers.

(9) As much as practical, place controllers in a central, easily accessible location inside a protective cabinet. The designer will evaluate the need for a cabinet for individual controllers.

(10) For areas having variable occupancy loads such as auditoriums, gymnasiums, classrooms, etc., consideration should be given to control of outside air volume through use of CO_2 monitors.

(11) Contractor will furnish as-built reproducible control drawings. (Note: the consultant furnishes all other reproducible as-built drawings.)

3.5.9.2 Equipment

(1) Actuators

(a) Pneumatic actuators are preferred.
(b) The use of positioners is preferred.

(c) For damper applications, use a minimum of one actuator for each 25 square feet of damper area.

(d) For valve applications, size valves, and actuators for full close and full open with a maximum of 18 pounds of air pressure.

(e) Actuators for outside air dampers and pre-heat coils will have a spring return.

3.6 ELECTRICAL

3.6.1 General Requirements

3.6.1.1 Electric service will be designed and installed to meet or exceed the latest revision of the National Electric Code.

3.6.1.2 Consultant to provide preliminary KVA size, proposed secondary voltage, and will perform fault current, harmonics, distortion (including neutral current estimate) and transformer load analysis.

3.6.1.3 Main power supplies to new buildings and distribution panels will be oversized for future requirements. A minimum of 20% spare capacity should be provided within each breaker panel board. Spare capacity is defined as 20% space feeder capacity and 20% spare poles within the panel.

3.6.1.4 Only UL or equivalent approved appliances and equipment will be specified.

3.6.1.5 Electrical kilowatt-hour meters will be provided in new buildings.

3.6.1.6 Exterior handicapped ramps will be electrically heated for snow/ice melting. Control from campus Energy Management System.

3.6.1.7 When installing or changing electrical equipment, the designer will evaluate available fault currents and size the ampere interruption capacity accordingly.

3.6.2 Secondary Circuits

3.6.2.1 General requirements

(1) All neutral conductors will be a minimum of full size. Designer will evaluate the need for oversized neutral conductors.

(2) The preferred method for grounding establishing a grounding electrode for equipment and structure is through the use of a buried loop, or in new construction, use of the concrete reinforcing steel. Driven grounds will not be specified where soil conditions consist of rock. In such conditions, use a counterpoise system or another approved alternative. The grounding electrode should have a resistance to ground in the range of 2-5 ohms. All grounding electrodes will be tested with the recorded resistance value approved by the designer.

(3) Building columns, roof steel, and footer steel reinforcing will be made electrically continuous for grounding purposes. Use of building steel for grounding will not be allowed unless the steel was designed for this use or grounding capability of the steel was tested and found adequate.

(4) Water lines, building steel, and a grounding conductor from existing building will be

bonded together.

(5) Designer will evaluate anticipated building loads for potential harmonic design requirements.

(6) No aluminum conductors or busses will be allowed. All conductors will be copper.

(7) Load centers will not be allowed. Minimum level of quality is a panel board or a switchboard.

(8) When installing or changing equipment, the designer will evaluate available fault currents and size ampere interruption capacity accordingly. All new switchboards and panel boards will be clearly labeled with designed short circuit current rating. Labels will be a permanently attached, non-aging material with waterproof, abrasion resistant lettering. Label lettering will be 5/32" or larger. Label should read as follows:

> Caution - This equipment has a minimum short circuit design requirement of ____ KA. All devices installed must have a rating equal or higher than the design requirement.

(9) Distribution of power, lights, fire alarm, telephone, and miscellaneous signals will be in conduit. Conduit systems may consist of rigid galvanized steel, IMC, EMT, or a combination of the three as required by applicable codes and standards.

(10) All conduit sizes and conductor numbers and sizes will be shown on the drawings.

3.6.2.2 Service entrance

(1) In new installations, it is preferred only one disconnect be installed per service entrance. However, if multiple disconnects are installed, no more than four (4) disconnects will be installed, with space allowed for a total of six (6) disconnects.
(2) All 480-volt service entrance main breakers or fused switches that are rated 1,000 amps or higher are required to have Ground Fault Protection (GFP). This equates to 665 kVA with a single main breaker of standard design.
(3) Where the service entrance disconnect is equipped with GFP, the consultant shall provide time and current setting for the GFP. The service entrance GFP will coordinate with feeder circuits that have GFP and small feeder breakers (such as 20 or 30 amps) in insure the feeder circuit will open before the GFP can trip the main breaker. Where the service entrance disconnect has GFP, feeder breakers that supply motor loads without isolation transformers shall have GFP.
(4) The service entrance disconnect will include sensing for a single-phase condition on the power system. A single-phase detection relay will have an adjustable time delay of 1 to 10 seconds before opening the main breaker and shall not operate for loss of voltage on all three phases. The relay shall only open the service entrance disconnect after loss of voltage to one phase has been detected for 10 seconds.

3.6.2.3 Branch circuits

(1) All exposed conduit installed in a finished space will be painted to match the background.
(2) All lighting switching layouts will be shown on the drawings. Drawings will show circuit numbers for each receptacle, and will show wire counts for all circuitry.
(3) Panel boards will be supplied with lighting sufficient for working at the panel board. In some cases this may require installation of additional lighting.
(4) Breaker circuits shall be marked in panels (required by Code).

3.6.3 Devices and Motors

3.6.3.1 Devices

(1) Each rest room must have at least one receptacle and it must be a GFI receptacle.

3.6.3.2 Disconnects

(1) Motors and other equipment not within sight of their feeder over current protection devices will be fed from disconnect switches located at the motor.

3.6.3.3 Motors

(1) All motors will meet ASHRAE 90.1 and (UMC Only: Energy Management Office [EMO] Energy Conservation Policy #060 [Appendix G-2]), and will have a minimum service factor of 1.15.
(2) Designer will evaluate the possibility of using 480v whenever practical.
(3) Designer will evaluate the use of soft starting whenever appropriate.

3.6.4 Lighting

3.6.4.1 Illumination design will comply with the Unit Power Density (UPD) defined in the latest edition of ASHRAE/IES Standard 90.

3.6.4.2 Provide local switching for all lighting. Offices, halls, equipment rooms, etc. will be provided with separate switches except for night-lights.

3.6.5 Lightning Protection and Grounding

3.6.5.1 Lightning protection system will be considered for new and renovated facilities. Consultant will calculate a "Risk Index" per NFPA-78, using a lightning frequency index of "3". All facilities with a Risk Index of "7" will be considered for lightning protection.

3.6.6 Communications and Alarm Systems

3.6.6.1 Telephone and data systems

(1) General guidelines

(a) The design of all communications systems will be coordinated with campus Telecommunications.

(b) In general, the contractor will install wall boxes and any required conduit. UMC Only: MU Telecommunications will install all wiring and termination devices. If the contractor will be installing any wiring on a particular project, the full cable specification will be obtained from MU Telecommunications.

(c) A minimum of one voice and one data cable will be installed for every 100 sf. of office area.

(2) Telecommunications closets and equipment rooms

(a) All telecommunications closets should be considered as potential locations for ancillary electrical equipment as well as basic termination of Cable/Wire/Fiber. Spaces will comply with EIA basic standards.

i) Size: minimum size requirements - 5' by 6' with door opening out or 5' by 8' with door opening into the room.

ii) Ceiling Height: 8' minimum ceiling height.

iii) Doorways: minimum measurement of 3' wide by 6' 8" high. These Measurements do not include a doorsill or center post.

iv) Location: a minimum of one telecommunications closet will be located on each floor. Distance limitations or other considerations may require more than one closet. Closets should be located as close to the core of the structure as possible and should be stacked one above the other in multiple floor buildings. One closet should be allocated for every 10,000 sq. ft. Average cable runs should be 150 horizontal feet with no

single cable run exceeding 295 feet.

v) Dust and static: install tile and/or seal concrete.

vi) Power: each closet must have a minimum of two 110V AC duplex outlet. Outlets must be separately fused, 20 amp, 3-wire grounding and on a non-switched circuit. Outlets should be located below the termination board location, if known.

vii) Grounding: ability to attach to building ground must be provided.

viii) Lighting: minimum equivalent of 538 lux measured at 4' above finished floor.

ix) Conduit/Cores: each closet must be constructed with a minimum of 2"-4" cores equipped with sleeves extending a minimum of 1" above finished floor. Two additional 4" cores are required for each additional 10,000 square feet per floor.

x) Environment: temperature ranges 65? F to 95? F; humidity ranges 20% to 60% relative; heat dissipation 750 to 5,000 BTU's per hour per cabinet.

xi) Security: all closets must be equipped with locking doors, handles must be knurled.

(3) Telecommunications Equipment Rooms

(a) Equipment rooms are special purpose rooms serving space needs for large pieces of telecommunications and computing equipment and may not be required in all buildings. The need for equipment rooms will be discussed with Campus Telecommunications. Equipment rooms are connected to all building distribution media and are required to have exacting environmental standards due to the nature of the equipment housed in the room. These rooms will meet the following requirements:

i) Size: minimum size requirements - 15' x 15' (225 square feet).

ii) Ceiling height: minimum 8'-6" .

iii) Floor: dust must be kept to a minimum. Tile floors and/or seal concrete. Floor loading minimum 100 lbs./sf. for equipment.

iv) Environment: temperature ranges 65? F to 95? F; humidity ranges 20% to 60% relative; heat dissipation 750 to 5,000 BTU's per hour per cabinet.

v) Electrical: each manufacturer's equipment is different. The following are requirements generic to all systems' requirements:

a) Dedicated branch circuits (unique, non-shared phase conductor, neutral conductor, equipment grounding conductor)

b) Sharing or daisy-chaining of any conductors is prohibited

c) Isolated grounding

d) Dedicated feeder

vi) Lighting: minimum equivalent of 538 lux measured at 4' above finished floor.

(4) Telecommunications service entrances

(a) Telecommunication facilities must enter and terminate in an area providing optimum utilization for end user requirements. All entrances will be underground, in conduit.

(b) Sizing of underground entrance facilities fluctuates with many variables but minimum conduits required for a building entrance will be as follows:

i) Two-4" conduits per 200,000 square feet of usable office space.

ii) One spare conduit for each 2 conduits to be used.

iii) No more than 2 - 90? bends between pulling points.

iv) All ends of metallic conduit must be reamed and brushed.

v) All conduits will have a pull string installed.

vi) Metal sleeves through foundation walls must extend a minimum 20' beyond the wall.

(5) Pathways (interior)

(a) Pathways must support cables and provide protection. Pathways should be planned to facilitate original installation of voice/data cabling as well as ongoing maintenance, additions, and relocations. For new construction and in renovations where possible, cable trays or conduit for horizontal distribution will be installed in corridors. In renovations of existing facilities, existing conduits or other pathways may be used.

3.6.6.2 Fire alarm systems

(1) Fire alarm systems shall be designed in accordance with NFPA Standards.

(2) All new buildings and major renovations will include a central, zoned, addressable, microprocessor based type fire alarm system with manual or automatic alarm initiation as required by code, analog addressable detectors, and alarm verification for alarms initiated by certain detector zones.

(3) Drawings for fire alarm systems will include zoning and locations for each device on the plan view and a riser diagram.

(4) Building zones shall be directed by the Project Manager.

(5) All new fire alarm panels must be expandable. Future ability to provide fire alarm service for entire building or planned building expansion is required. Each notification circuit shall contain a minimum of 20% excess capacity. The 20% capacity should be in addition to the capacity for any planned expansion of the fire alarm or voltage drop.

(6) All fire alarm panels will be located at the main entrance of the building or will have a remote annunciator located at the main entrance or as directed by the Project Manager.

A diagram of the building showing various zones will also be located at the main entrance.

(7) If a new fire alarm system is being installed in an existing building, the existing fire alarm system shall be maintained fully operational until the new equipment has been tested and accepted.

(8) Pull stations will be located at all building and floor entrances.

(9) If a security system is available in the building where a new fire alarm panel is being installed, trouble and alarm outputs from the fire alarm panel will be connected to the security system to allow reporting of a fire alarm to Campus Police through the security system. All fire alarm panels will be capable of reporting through the security system or other external system.

(10) If an Energy Management Controls System (EMCS) is available in the building where a new fire alarm panel is being installed, trouble and alarm outputs from the fire alarm panel will be connected to the EMCS.

3.6.6.3 Security systems

(1) All security systems must be compatible with the security system in use by University Police. Design of security systems will be coordinated with University Police.