4.0 OUTLINE SPECIFICATIONS & DETAILS

4.1. Introduction

This section contains information to be used by consultants in the preparation of project specifications.

The criteria represent minimum levels of performance, quality and/or standardization that should be enhanced by the consultant and made project specific.

The individual guidelines are grouped under the applicable CSI divisions.

4.2. SITE WORK

4.2.1 Excavation and Backfill

1. All activities will be contained within construction boundaries indicated on site plan. Specified excavation requirements, precautions, and protective systems will be observed at all times.

2. Movement of trucks and equipment on Owner's property will be in accordance with Owner's instructions.

3. Topsoil will be stripped from the construction site and stockpiled in designated area. At UMC, topsoil will be stripped and disposed of legally off site.

4. Trenches will not be backfilled until all required tests are completed and the utility systems, as installed, conform to requirements specified by the contract documents.

5. Rock quantities anticipated to be removed in classified excavation as a part of the base bid will be either stated in Division 2 or on the bid form. Add/deduct unit prices for rock removal will be included on the Bid for Lump Sum Contract Form. Relatively accurate estimates of rock removal are important for defining accurate construction estimates.

6. For purposes of identifying and measuring rock, which may be encountered during classified excavation, the following definitions will be used. The definitions are based on minimum equipment requirements, which must be equaled or exceeded by the contractor. If the contractor chooses to use equipment of lesser size, capacity, or power than specified for excavating purposes, the contractor will assume all responsibility for the cost and method of removal of material resembling rock, which cannot be removed with their equipment. Therefore, contract unit prices submitted by the contractor for rock excavation will only be applicable if the contractor's equipment equals or exceeds equipment requirements specified below:

   a. Open Excavation

      Rock excavation in open excavations will include removal and disposal of any sound and solid mass, layer or ledge, regardless of origin, which cannot be effectively loosened or broken down in multiple passes in opposite directions.

A late model crawler-type tractor rated with at least 170 net flywheel horsepower, equipped with a hydraulic ripper with one digging point of standard design and size, and with tractor operating in low gear.

b. Pit and/or Trench Excavation

Rock excavation in trenches and pits will include removal and disposal of any sound and solid mass, layer or ledge, regardless of origin, which cannot be excavated and removed by a 3/4 cubic yard capacity hydraulic backhoe, rated at not less than 90 net flywheel horsepower, and 30,000 pound drawbar pull.

c. Drilled Pier Excavation

(1) Weathered rock/shale pier excavation is defined as any material that cannot be drilled or removed with conventional earth augers and requires the use of rock augers for drilling.

(2) Rock excavation is defined as any sound and solid mass, layer or ledge, regardless of origin, which cannot be drilled with conventional earth augers or underreaming tools and requires alternate drilling methods for removal, such as special core barrels, air tools, and/or other methods of rock excavation. (The minimum size drill rig is one with a rated positive crowd force of 37,000 pounds and a continuous torque rating of 25,000 foot pounds).

7. Disposal on Owner=s designated site (use as directed by the Project Manager [PM]): contractor will remove excess suitable fill materials from project site and dispose of materials on the Owner's designated site. The distance contractor will have to haul materials for disposal will be in the contract documents. Contractor will level off fill materials at dump site. Unsuitable fill will be disposed of legally off the Owner's property.

8. Disposal off-site (use as directed by PM): contractor will remove excess suitable and unsuitable fill materials from project site and dispose of legally off the Owner's property.

9. Consultant will specify inspection and testing requirements and will include procedures for evaluation of test data. All bearing soil and backfill will be inspected and tested immediately prior to placement of reinforcing steel and concrete and at the discretion of the Owner=s representative and the soils engineer. Owner will retain the services of an engineering inspection and testing firm. Contractor will be responsible for coordinating and scheduling inspections.

10. On UMC projects, rough grade for the contractor will be 6" below finish grade. Topsoil and finish grading will be by the Owner.

11. Backfill and subgrade compaction will conform to geotechnical engineer recommendations. For projects without a geotechnical report, the following criteria shall be specified:

    a. Bearing soil for spread footings, pad footings, and slabs on grade shall be compacted to a minimum of 95% of maximum density at optimum moisture content (-2% to +4%) standard proctor. Excavation to undisturbed soils is not considered adequate.

    b. Backfill for foundations shall be compacted to a minimum of 88% and a maximum of 92% of maximum density under landscaped areas and a minimum of 95% of maximum density under other areas at optimum moisture content (∀ 2%) standard proctor. Backfill shall be installed in no more than 12" lifts. Specific soils or situations may require smaller lifts.

    c. Backfill for trenches should be well graded granular materials ¾" to 1" clean material vibrated in lifts.

12. Proof rolling shall be specified for areas to be paved and shall conform to the geotechnical engineers recommendations. For projects without a geotechnical engineer's recommendation, the following criteria will be specified:

    All areas to be paved that are of sufficient size to permit the required equipment shall be proof rolled prior to placement of the aggregate base course. Proof rolling shall consist of passing/driving a loaded, 20-ton, tandem dump truck over the prepared subgrade soil with a maximum allowable displacement of 1". Any areas that displace more than 1" shall be compacted until this criterion is met, or those areas may be excavated and backfilled with compacted Type 1 Aggregate for Base. All proof rolling shall be performed in the presence of the Owner's Representative.

4.2.2 Demolition

1. PM will designate material removed by demolition that is to remain on the University's property before completion of final review documents.

2. Materials acquired through demolition, other than those required to complete the construction project and designated for return to Owner, will become the property of the

contractor and will be removed from the site and off University property in accordance with the Owner's instructions. The material will be disposed of in a legal manner.

3. All asbestos materials are to be removed before general demolition.

4.2.3 Hazardous Materials

4.2.3.1 Asbestos Containing Materials

a. The University will furnish the consultant a completed asbestos removal specification. These are to be inserted into Division 2 and will be considered a part of the contract documents. Asbestos specifications will be furnished after the final contract documents review meeting along with the advertisement (See Appendix E - Asbestos Removal Specifications).

b. The University will retain an asbestos consultant through a separate agreement to develop and provide the survey and abatement documents. Consultant should coordinate with the asbestos consultant in the development of contract documents.

c. Asbestos consultant should be listed as a special consultant to the Owner in the Special Conditions. The asbestos abatement specifications should be listed in the project manual table of contents.

4.2.3.2 Lead Based Paint – See Appendix 16a

4.2.3.3 Miscellaneous Hazardous Materials

a. PCB containing material may be present in existing fluorescent light fixture ballasts. PCB containing ballasts shall not be discarded in the regular trash or demolition debris. PCB containing ballasts not salvaged shall be removed from the fixture and turned over to the Owner for disposal at no cost to the Contractor. Fluorescent light fixtures containing non-PCB ballasts may be salvaged. These ballasts must have a label that specifies no PCB, Non-PCB, or PCB Free. The contractor must properly remove the light fixtures intact and relocate them as directed by the Owner.

b. Mercury Vapor Fluorescent Lamps may be salvaged if the Contractor removes the fixture without breaking the tube and removes them from the site as directed by the Owner. If fluorescent tubes are not to be reused, they must be recycled. The contractor shall remove the tubes fixtures undamaged, pack them securely in tube boxes, and ship them to a fluorescent tube recycler. Fluorescent lamp tubes shall not be discarded in the regular trash or demolition debris. (See Appendix 16b)

c. Mold growth may be present existing building materials. Use standard mold remediation (“clean-up”) techniques to properly control and dispose. Report unusual or

severe mold growth to Project Manager. Reference EPA Publication 402K81001, March 2001.

4.2.3.4 Acid Dilution Underground Tanks shall not be used.

4.2.4 Asphalt and Portland Cement Concrete Paving

1. Asphalt/Portland cement concrete pavement, will be designed according to the following guidelines:

   a. Roadway: (rigid and flexible) AASHTO Guidelines for the Design of Pavement Structures, 1986

   b. Parking Lot:
   Rigid - Portland Cement Association
   Flexible - The Asphalt Institute

   c. Walkways will have a minimum compressive strength of 4000 psi for 28 days.

   d. All exposed concrete (including precast concrete) will be air entrained according to the Chart in Division 3 in this standard..

   e. Flint and chert will be limited to 1% maximum, by weight of the coarse aggregate, in all exposed concrete (cast-in-place or precast). Lignite will be limited to 0.07%, by weight of the fine aggregate in all exposed concrete. Some applications may be required to be lignite free (project manager will advise).

2. Asphalt surfaced parking lots will have a minimum cross section of 3" of asphalt surface prime coat, 6" of crushed stone Type 1 aggregate for base, and an underlayment of geotextile fabric.

3. Concrete surfaced parking lots will have a minimum cross section of 6" of concrete and 4" of Type 1 aggregate for base. The concrete will be portland cement concrete with a heavy broom finish. All joints will be shown on the plans and will be sealed with traffic grade caulking.

4. All concrete walks and drives will be reinforced with a (UMC only: #3 rebar at 18" centers each way) 6x6/10xl0 welded wire fabric or rebar. At UMC, dowels shall not be epoxy coated. Steel shall be at the approximate mid-point of the concrete depth.

a. Concrete strengths will be specified in accordance with actual requirements. Concrete mix will be specified with minimum cement content, as well as maximum water/cement ratio.

b. Fibers (non-asbestos) can be used in addition to steel to control shrinkage cracking.

5. Consultant will specify inspection and testing requirements and will include procedures for evaluation of test data. For UMSL and UMKC projects, the contractor will retain services of a concrete testing firm. For UMC and UMR projects, the University will retain services of a testing firm. Contractor will be responsible for scheduling the tests. Contractor will be required to notify the Owner=s representative a minimum of 48 hours prior to all placement of concrete.

Specifications will require strength, air entrainment, temperature, and slump tests, and will indicate allowable limits for each measure. Strength tests will require 4 cylinders (3 to be broken and 1 spare). Test results will be specified to be sent directly to the contractor, architect, and the Owner=s representative.

Concrete will be tested at the minimum rate of one test for the first 25 cubic yards [CY] placed each day, and one test for each additional 50 CY placed. Concrete may be tested more often at the discretion of the Owner=s representative.

Test data from concrete cylinder breaks will be evaluated using procedures of the American Concrete Institute (latest edition of ACI 214) to determine if the compressive strength of the concrete tested is acceptable.

6. All concrete walks and drives will be constructed on a minimum of 4" of compacted crushed stone base course. Gradation of the crushed stone will be as required for Type 1 aggregate.

7. Sand will be from local sources meeting ASTM C-144 for mortar and ASTM C-33 Size 67 for concrete. If matching of color is necessary, sand for mortar and concrete will be from the following sources:

UMC - Missouri River
UMSL - Meramec River
UMKC - Kaw River
UMR - Meramec River/Little Piney

8. At UMC only, driving surface pavement patches for utility cuts will include 8" of concrete with #4 transverse bars (to the patch centerline) at 18" maximum centers and 2-#4 longitudinal bars. Patch will extend 1-foot minimum outside the trench. Patch surface shall be concrete with abutting concrete paving or 2" of asphaltic concrete/tack coat with abutting asphalt surface.

9. Joints and Concrete Flatwork

   a. Expansion joints shall be installed to provide for thermal expansion of concrete pavements. Generally expansion joints shall be provided at the PC and PT of curves where the deflection angle is greater than 30E and intersections. If required for load transfers, expansion joints will be detailed with dowel bars to allow load transfer and expansion of the concrete slabs. Non-extruding expansion joint material will be used with expansion joints.

   b. Portland cement concrete flatwork will be isolated from manholes, existing walls, etc., by use of expansion joints.

   c. Contraction joints shall be tooled during finishing or sawed within 18-hours of concrete placement. If the joint edge ravels, stop, do not proceed until concrete has sufficient cure to saw without damage. Refer to 4.3.3 for further requirements.

   d. Construction joints will be located at expansion joint locations wherever possible. Construction joints at other locations will be keyed.

   e. All joints will be sealed with traffic grade, non-asphalt, non-extruding sealant.

   f. Joint spacing and joint detail will be shown on the drawings.

10. Paint colors will be white for general lot striping, yellow for no parking areas, and blue for accessible spaces and areas. Lead bearing substance paints are prohibited.

4.2.5 Site Utilities

4.2.5.1 Storm Sewers

1. Storm sewer pipe shall be reinforced concrete pipe conforming to ASTM C76 or AASHTO M170, Class 3 minimum, and asbestos-free.

a. Joints shall be flexible rubber gasket conforming to ASTM C443 or ASTM C361.

b. The minimum pipe size for storm drains is 12".

2. Area drain piping shall be 8" or larger. Pipe shall be:

a. Ductile iron conforming to ASTM A746 with cement lining conforming to ANSI/AWWA C104/A21.4, and asphaltic coating on the interior and exterior conforming to ANSI/AWWA C110/A21.10, and asbestos-free.

b. Polyvinyl chloride (PVC) conforming to ASTM D2241, PVC 1120, DR 21, PR 200 (SDR-21).

3. Perforated pipe for subgrade drains shall be SDR-35 or Schedule 40 PVC. Pipe shall be installed in a geotextile envelope with clean rock. Perforated pipe in a 'sock' is not acceptable.

4. Inlets and junction boxes may be cast-in-place or precast conforming to ASTM C478.

a. Storm manholes (junction boxes) shall use a Deeter 1247, Neenah R-1642, or exact equal frame and lid. The lid shall be lettered with the words 'Storm Sewer' or 'Storm Drain'.

b. Structures over 3-feet from lid to lowest flow line shall include steps. Steps shall be Neenah 1980-J, Deeter 1606, M.A. Industries PS2-PF, or equal.

4.2.5.2 Sanitary Sewers

1. Sanitary sewers shall be constructed in accordance with the standards and requirements of the Missouri Department of Natural Resources and local regulatory agency (MSD, City of Columbia, Rolla, or Kansas City).

2. Sewer piping installation shall include granular bedding and backfill within the pipe envelope.

a. Trench backfill in yard areas shall generally be soil compacted, in continuous layers not exceeding 8" in compacted depth, to 90% Standard Proctor Density.

b. Trench backfill under pavements shall generally be granular material compacted, in continuous layers not exceeding 8" in compacted depth, to 95% Standard Proctor Density.

c. Maintain –2% to +4% optimum moisture content for cohesive soils. For cohesionless soils, maintain moisture at less than +4% of optimum moisture content.

3. The minimum service line size shall be 6". The minimum sewer line shall be 8".

4. Sanitary Sewer Pipe shall be:

a. Ductile iron conforming to ASTM A746 with cement lining conforming to ANSI/AWWA C104/A21.4, and asphaltic coating on the interior and exterior conforming to ANSI/AWWA C111/A21.11, and asbestos-free.

b. Polyvinyl chloride (PVC) conforming to ASTM D2241, PVC 1120, DR 35, PR 200 (SDR-21). Joints shall conform to ASTM D3033/D3034, Type 1, Grade 1.

5. Manholes shall be pre-cast concrete conforming to ASTM C478 or ASTM C76, Class 3.

a. Joints shall conform to ASTM C361 or ASTM C443.

b. Pipe openings shall be provided with flexible connectors designed to produce a positive watertight connection for pipes entering the manhole. Connectors shall be A-LOK or equal.

c. Grade rings shall conform to ASTM C478.

d. Waterproofing shall consist of two coats of asphaltic pitch conforming to ASTM D449, and shall be asbestos-free.

e. Standard frame and lid shall use a Deeter 1247, Neenah R-1642, or exact equal frame and lid. The lid shall be lettered with the words 'Sanitary Sewer'. Watertight frames and lids shall be used in areas with high infiltration potential and in Regulatory Flood Plains.

f. Manhole steps shall be Neenah 1980-J, Deeter 1606, M.A. Industries PS2-PF, or equal.

6. 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.

    a. Cleanout material shall be cast iron.

    b. Frame and casting shall be Neenah R-1976, Deeter 1830, or equal. Casting shall be anchored by a 2' x 2' x 8" thick concrete pad, 6" below finished grade. Separate concrete from pipe with two layers of Building Paper.

    c. End of line cleanouts shall use long radius bends and include a concrete cradle under the bends. PVC shall not extend above grade.

4.2.5.3 Waterlines

1. Waterline pipe shall conform to AWWA standards and the requirements of the MoDNR.

2. Waterline pipe installation shall include granular backfill within the pipe envelope. Granular or soil bedding shall be provided.

    a. Provide 36" minimum cover.

    b. Trench backfill in yard areas shall generally be soil compacted, in continuous layers not exceeding 8" in compacted depth, to 90% Standard Proctor Density.

    c. Trench backfill under pavements shall generally be granular material compacted, in continuous layers not exceeding 8" in compacted depth, to 95% Standard Proctor Density.

    d. Maintain –2% to +4% optimum moisture content for cohesive soils. For cohesionless soils, maintain moisture at less than +4% of optimum moisture content.

3. UMC Only: All water meters will be located inside buildings. See Division 15 specifications for building piping and metering.

4. Valves will be installed with a vertical piece of PVC pipe and a cast iron valve box cover, with lid marked 'Water'. Casting shall be anchored by a 2' x 2' x 8" thick

concrete pad, 6” below finished grade. At UMC only, Project Manager will provide details.

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

6. All joints shall be restrained. In addition to joint restraints, bends shall include stainless steel tie rods and reaction backing. At UMC only, Project Manager will provide details.

7. Fire hydrants shall be provided in accordance with the requirements of the local fire district or department. For UMC, fire hydrants shall be Mueller Super Centurion 250. At UMC only, Project Manager will provide details.

8. Waterlines shall be provided with a tracer wire, with outlet at valve boxes, and warning tape. At UMC only, Project Manager will provide details.

4.2.5.4 Gas Mains and services shall have a minimum of 24” of cover.

4.2.5.5 Refer to Division 15 for utilities within a building envelope.

4.2.6 Landscape

1. Owner will be notified prior to grade changes during backfilling and prior to the establishment of the "rough grade" (existing grade prior to application of top soil or growing medium for turf or other plants).

2. Owner will be notified prior to applying top soil or growing medium for turf or plants for the purpose of establishing the finish grade.

3. Soil or growing medium for turf or plants will be examined and approved by the Owner as to its physical properties, fertility level, and weed content before application.

4. Planters will be checked for adequate drainage by the Owner before filling. Planters will be filled with specific soil mixtures. For UMC projects, tree grates within the City of Columbia right-of-way are required to be 3' x 5'.

5. Landscape plant materials will be in accordance with the American Association of Nurserymen's Standards.

6. Landscape installer will provide typewritten instructions to the Owner for the maintenance of plant materials for one full year. Instructions will be submitted upon completion of planting.

7. Landscape plants will be maintained by the contractor for a thirty (30) day period following planting.

4.2.7 Site Furnishings

1. Bicycle racks will be as manufactured by Brandir International, Inc., New York, New York.

2. Trash receptacles will be Model TR-29-R with fiberglass lid and plated bag rack as manufactured by Architectural Precast, Inc., Columbus, Ohio.

3. UMC Only: Ash urns will be model AT-12-R as manufactured by Architectural Precast, Inc., Columbus, Ohio, or approved equal.

4. UMC Only: Benches will be model UB-614, 6', redwood, as manufactured by Victor Stanley, Dunkirk, Maryland, or approved equal. Benches will be in ground mount with a concrete pad.

5. UMC Only: Picnic tables will be model CP-2R as manufactured by Victor Stanley, Dunkirk, Maryland, or approved equal. Tables will be in ground mount with a concrete pad.

END OF SECTION

4.3 CONCRETE

4.3.1 This section applies to all building systems concrete work and cast-in-place site structural concrete outside building envelopes.

4.3.1.1 Mix Design and Materials

1. Concrete strengths will be specified in accordance with actual requirements. Concrete mix will be specified with minimum cement content, as well as maximum water/cement ratio.

2. All exposed concrete (including precast concrete) will be air entrained according to the following:

Maximum Aggregate Size	Average Total Air Content	Total Air Content Range
3/8”	7.5%	6.5% - 9.5%
½”	7.0%	6.0% - 9.0%
¾”	6.0%	5.0% - 8.0%
1”	6.0%	5.0% - 8.0%

3. Flint and chert will be limited to 1% maximum, by weight of the course aggregate, in all exposed concrete (cast-in-place or precast). Lignite will be limited to 0.07%, by weight of the fine aggregate in all exposed concrete. Some applications may be required to be lignite free (Project Manager [PM] will advise).

4. The use of calcium chloride and/or flyash in concrete mixes will not be permitted.

5. All accessories touching the exposed surface of the concrete or come in contact with soil will be coated with plastic or epoxy to prevent rust.

6. Precast concrete

   a. Fabricator must show compliance with the following codes and standards:
      (1) ACI-318 "Building Code Requirements for Reinforced Concrete"
      (2) CRSI "Manual of Standard Practice"
      (3) Prestress Concrete Institute MNL117, "Manual for Quality Control for Plant and Production for Architectural Precast Concrete Products."

   b. The Fabricator will have a minimum of three (3) years successful experience in the fabrication of precast concrete units similar to the units required for this

project. Fabricator will guarantee the connections and will submit their design to the consultant for review.

c. The Erector will have a minimum of two (2) years successful experience erecting similar precast units.

d. Shop drawings shall be prepared by a Registered Professional Engineer licensed to practice in the State of Missouri.

4.3.2 Testing

1. Consultant will specify inspection and testing requirements and will include procedures for evaluation of test data. For UMSL and UMKC projects, contractor will retain the services of a concrete testing firm. For UMC and UMR projects, the University will retain services of a testing firm. Contractor will be responsible for scheduling the tests. Contractor will be required to notify the Owner=s representative a minimum of 48 hours prior to all placement of concrete.

2. Specifications will require strength, air entrainment, temperature, and slump tests, and will indicate allowable limits for each measure. Strength tests will require four (4) cylinders (3 to be broken and 1 spare). Test results will be specified to be sent directly to the contractor, architect, and the Owner=s representative.

3. Concrete will be tested at the minimum rate of one test for the first 25 CY placed each day, and one test for each additional 50 CY placed. Concrete may be tested more often at the discretion of the Owner=s representative.

4. Test data from concrete cylinder breaks will be evaluated using procedures of the American Concrete Institute (latest edition of ACI 214) to determine if the compressive strength of the concrete tested is acceptable.

4.3.3 Placement

4.3.3.1 Joints and Concrete Flatwork

1. Contraction joints shall be tooled during finishing or sawed within 18-hours of concrete placement. If the joint edge ravels, stop, do not proceed until concrete has sufficient cure to saw without damage.

a. Contraction joints shall have a minimum depth of 1/4 of the pavement thickness and a minimum width of 1/8”.

b. Transverse contraction joints will be provided at a maximum of 2.5 times the pavement thickness (in inches) in feet for street pavements and 2.0 times for all other pavements.

c. Longitudinal joints shall have a maximum separation of 12 feet for streets and 9 feet for sidewalks.

d. The ratio of slab width to length should not exceed 1.67 for street pavements and 1.25 for all other pavements.

e. Some variance in spacing will be permitted to achieve desired architectural effect.

2. Concrete flatwork will be isolated from columns, existing walls, etc., by use of non-extruding expansion joint material.

3. Base course and underslab drainage system for slabs will conform to geotechnical engineer recommendations. For projects without a geotechnical report, slabs will be constructed on a minimum 4" base of 3/4"-1" clean rock with a plastic vapor barrier.

4. UMC Only: all slabs below grade shall have a sump hole. Provide an electrical outlet by the sump hole. The campus will provide the sump pump.

5 Slab flatness and levelness will be within 1/8" in 10'. ASTM E1155 will not be used to specify flatness and levelness unless the particular use requires a high level of accuracy. Areas having floor drains will have positive slope to the floor drain. Amount and direction of slope for floor drains will be indicated on the drawings.

6. Construction joints will be located at expansion joint locations wherever possible. Construction joints at other locations will be keyed.

7. Joint spacing and joint detail will be shown on the drawings.

4.3.4 Exposed Concrete

1. All exposed concrete will conform to the applicable sections of V.B.3A.

2. Exposed concrete intended as a finish material shall be clearly defined in the drawings and specifications. Areas to be addressed should include special formwork, form liners,

acceptable defects (if any), surface repairs and surface treatments (i.e.: sandblast, rubbing, etc.)

END OF SECTION

4.4 MASONRY

4.4.1 Brick and Block Masonry

1. 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.

   Particular emphasis is placed upon the following BIA sections:

   a. Articles 21, 21A, 21B, 21C/Brick Masonry Cavity Walls.
      (1) Tie Spacing (4.5 square feet per tie, maximum 24" on center vertical, and maximum 36" on center horizontal).
      (2) Movement Joints (Articles 18 and 18A).
      (3) Flashings (placement, protrude 1/4" beyond face of wall and form a drip).
      (4) Weeps (24" on center with tubes, 16" on center with wicks, located above flashings).
      (5) Air Space (2" minimum kept clean of mortar droppings).

   b. Article 28B/Brick Veneer Steel Stud Panel Walls
      (1) Tie Spacing (2 square feet per tie, maximum 18" on center vertical, and maximum 24" on center horizontal).
      (2) Movement Joints (Articles 18 and 18A).
      (3) Flashings (placement, protrude beyond face of wall and form a drip).
      (4) Weeps (24"on center with tubes, 16" on center with wicks, located above flashings).
      (5) Air Space (2" minimum, kept clean of mortar droppings).

2. Brick allowances are discouraged. Allowances will be specified for brick only if specific selections cannot be made.

3. All brick (including that incorporated into the face of architectural precast panels) will comply with ASTM C216 and will have a rating of "no efflorescence" when tested according to ASTM C67.

   Lab certification of brick will be based on samples taken from bricks produced for the project and will be approved prior to delivery. At UMC, the Owner will retain an independent testing agency that will randomly test brick delivered to the site for compliance.

4. Brick used as paving material must be paving grade and will be set in a concrete base with an asphalt leveling course.

4.4.2 Stone Masonry

1. Limestone will be supplied following the guidelines of the Indiana Limestone Handbook, current edition.

2. Coping stones will be secured with stainless steel anchors and pins and will have a continuous rubber membrane flashing beneath the stones that extends flush to the surface of the wall, but not past the exterior surface. All head joints of coping stones will have joint sealant installed rather than mortar or grout.

4.4.3 Mortar, Flashing, Weep Holes, and Anchors

1. Mortar for Masonry Units and Manufacture of Masonry Units will conform to ASTM Standards on Masonry - 1990 Edition. In particular, C91-89 (Standard Specification for Masonry Cement) and C270-89 (Standard Specification for Mortar for Unit Masonry) will apply.

2. All shelf angles, fasteners, and other metal objects incorporated into masonry walls will be hot dipped galvanized. On UMC projects, fasteners will be stainless steel.

3. All flashings should extend 1/4" beyond the face of wall. In-wall flashings should be composite copper asphaltic felt. Through-wall flashings shall be stainless steel. Weeps shall be installed above each flashing.

4. Wall ties will be hot dipped galvanized steel, of a material, construction and movement quality equal to Hohmann & Barnard, Inc., DW10 Box Wall Tie.

5. At load bearing joints of different types of materials (brick and stone, brick and concrete, etc.), mortar will be raked back a sufficient depth to allow the installation of backer rod and sealant. Sealant installation details will comply with the manufacturer=s recommendations.

END OF SECTION

4.5 METALS

4.5.1 Structural Steel

1. If the AISC "Code of Standard Practice for Steel Buildings and Bridges" is used or referenced, the specifications will modify that code by deletion of the following sentence in paragraph 4.2.1: "This approval constitutes the Owner's acceptance of all responsibility for the design adequacy of any detail configuration of connections developed by the fabricator as a part of their preparation of these shop drawings."

2. Specifications will clearly state the responsibility for the design of steel connections. The responsible party must seal the connection designs.

3. Certified (AWS D1.1) welders will be used on structural work.

4. Consultant should consider use of twist-off ALegume@ bolts and load indicator washers for field structural connections.

5. Pre-engineered metal building roof purlins will be adequately braced on the compression flange to resist all design loads. Purlin slide clips commonly used with standing seam systems will not be considered an effective brace for the purlin. Separate purlin bracing such as threaded rods or sag angles must be provided in addition to the slide clips.

4.5.2 Testing

1. Consultant will specify inspection and testing requirements and will include procedures for evaluation of test data. For UMSL and UMKC projects, the contractor will retain the services of a structural steel testing firm. For UMC and UMR projects, the University will retain the services of an independent testing firm to test all steel connections. Contractor will be responsible for scheduling tests. Contractor will be required to notify the Owner=s representative a minimum of 48 hours prior to the time testing is needed.

2. Test results will be specified to be sent directly to the contractor, architect and the Owner=s representative.

4.5.3 Miscellaneous Metals

1. At exterior guardrails and handrails that are not a significant part of a building=s architecture, construction will consist of fully welded hot dipped galvanized steel pipe (galvanize only the lower 18" on UMC projects). Infill panels will consist of vertical balusters. Support posts will be set in sleeves oversized 1" cast into the walk. On UMC projects, railings will be painted black with high gloss enamel paint. Non-shrink non-metallic grout will be used and will slope to drain.

2. Specifications will require a mock up panel for all welded railings, grilles and similar architectural metal elements.

END OF SECTION

4.6 WOOD &PLASTICS

4.6.1 Rough Carpentry

1. Fire retardant lumber, used where required by code, will be in accordance with American Wood Preservers Association standards.

2. Where wood is in contact with ground or moisture, a material suitable for such application shall be used, however CCA is not recommended.

4.6.2 Architectural Millwork and Cabinetry

1. All architectural millwork and cabinetry will meet Architectural Woodwork Institute standards, and finish shall be free of lead bearing substances.

2. The use of more durable solid surfacing materials for windowsills is encouraged. Plastic laminate on solid wood or exterior grade plywood is acceptable. Standard particleboard is not acceptable.

3. Countertops should minimize seams. On UMC projects, plastic laminate countertops should have a plywood substrate. Sprayed on glue application for plastic laminate is not recommended.

END OF SECTION

4.7 THERMAL & MOISTURE PROTECTION

4.7.1 General

1. Materials used for moisture protection will comply with specifications contained in the appropriate American Society for Testing and Material standards.

2. All roofing materials shall be asbestos free.

3. Roof manufacturer approval process:

   All roof systems are pre-approved by the University. This is an internal process, consisting of the following:

   a. Roof manufacturer submits the following information to the UM Roofing Committee:
      (1) Roof system technical data
      (2) List of approved regional installers
      (3) List of regional projects completed over the last three years detailing:
         (a) Roof area and cost
         (b) Project owner and contact person
         (c) A/E design firm and contact person

   b. The UM Roof Management Committee, with the assistance of the UM roof consultant, evaluates all aspects of the proposed system.

   c. If necessary, the manufacturer meets with committee to review submitted materials and respond to questions.

   d. UM Roofing Committee in consultation with UM roof consultant approves or rejects the roof manufacturer. In addition, updated listings are included in the most current version of the Consultant Procedures and Design Guidelines

4.7.2 Roofs

1. Design Standards include:

   a. Factory Mutual (FM) I90 wind requirements for roof system approval.

   b. Underwriters Laboratory (UL). UL labels are required for each membrane, with top side fire rating meeting ASTM E108 Class A.

c. National Roofing Contractors Association (NRCA), Roofing and Waterproofing Manual, 4th Edition - 1996.

d. Sheet Metal and Air Conditioning Contractor=s Association International (SMACNA), Architectural Sheet Metal Manual, 5th Edition - 1993.

e. American Society for Testing and Materials (ASTM) standards for polymer-modified bitumen: D5147, D6162, D6163, and D6164.

2. Consultants will base roof specifications on the University of Missouri's Design Guidelines. The systems/manufacturers are prequalified:

EPDM
Carlisle Corporation
Firestone Building Products Company – Performance Roof Systems
Versico, Inc. *(App Derby Gum tentative acceptance)*

CSPE
JPS Elastomerics Corporation
Burke Rubber Company

CPA
Duro-Last Roofing, Inc.
Seal-Dry/USA, Inc.

PVC
Sarnifil Corporation (limited application due to proprietary product nature)

Built-Up Roofing Systems/Coal Tar
Allied Signal Inc.
Koppers Industries Inc.

Built-Up Roofing Systems/Asphalt
Johns-Manville
Tamko Asphalt Products Inc.
U.S. Intec

Modified Bitumen SBS
Garland Company Inc.
Johns-Manville
Tamko
Siplast
US Intec Inc.
Firestone Building Products Company

Metal Roofing Systems	
Atas Aluminum Corporation	Monarch
Butler Manufacturing Company	VSR
Centria	SRS
MBCI	Lok-Seam
Steelox Systems, Inc.	CF/SD
Vincent Metals	System 1

3. Recommended Roof Membrane and Insulation Assemblies

a. Built-up asphalt (BUR)

Membrane: four plies of Type IV glass felts in Type I or Type III asphalt moppings. Coal tar roof assemblies shall be considered with existing no slope roofs or new low slope roofs (less than 1/4" per foot). Type VI felt can be used in lieu of Type IV felt. On nailable substrates, a coated base sheet should be employed with three plies of Type IV. Base sheets should not be utilized under other circumstances.

Insulation: R-20 minimum rigid polyisocyanurate or extruded polystyrene (as part of roof manufacturer's approved system and included in the total system warranty). Mechanically fastened except over concrete deck or vapor retarder. Extruded polystyrene is preferred if approved by the manufacturer.

The insulation specified shall be compatible with the application method required and the other materials of the roofing system and shall be included in the total system warranty.

It is required that insulation be installed in more than one layer with staggered joints. Use of a recovery board is not considered a layer.

Substrate Board: 3/4" thick organic fiberboard or perlite for exterior fire rating Class A. Built-up roofs should never be installed directly over polyisocyanu-

rate. Substrate board to be installed with staggered joints and adhered in asphalt as part of total roof system.

Surfacing: flood coat with surface granulating or a fibrated aluminum coating for Class A rating.

Base Flashings: mineral surfaced modified bitumen sheets. Polyester fabric and modified mastic applies to top edge and side laps. Where deck-wall movement is likely (metal deck, masonry walls), use SBS type with polyester reinforcement only. Install in two components within 20' of corners and expansion joints. Avoid APP type at non-nailable substrates. Use SBS type with polyester reinforcement at low profile expansion joints and control joints. Use SBS type with granule surfacing and polyester reinforcement as walkways.

Anchor membrane with non-ferrous termination bars and stainless steel fasteners at wall/deck transition. Termination bars to be covered with a reglet and counter-flashing even if not required by manufacturer=s warranty.

b. SBS Type Modified Bitumen Sheet System

Membrane: to consist of a base sheet, interply sheet and cap sheet of SBS type sheets bonded with hot asphalt or approved adhesives. Hot asphalt is encouraged where roof accessibility is not a problem. A special fire rated sheet may be necessary to meet Class A requirements. Polyester or fiberglass reinforcement is allowable per manufacturer's roof systems. Standard test methods for sampling and testing Modified Bitumen material shall comply with ASTM D-5147, D-6162, D-6163, D-6164.

Insulation: R-20 minimum rigid polyisocyanurate or extruded polystyrene (as part of roof manufacturer's approved system and included in the total system warranty). Extruded polystyrene is preferred if approved by the manufacturer.

The insulation specified shall be compatible with the application method required and the other materials of the roofing system and shall be included in the total system warranty.

It is required that insulation be installed in more than one layer with staggered joints. Use of a recovery board is not considered a layer.

Substrate Board: 3/4" thick organic fiberboard or perlite for exterior fire rating Class A (as part of roof manufacturer's approved system). Modified bitumen

roofs should never be installed directly over polyisocyanurate. Substrate board to be installed with staggered joints and adhered in asphalt as part of total roof system.

Surfacing: ceramic granule surfaced cap sheet, white in color, unless otherwise recommended.

Base Flashings: SBS material furnished and installed per roof manufacturer=s recommendations. Use SBS type with polyester reinforcement only. Install in two components within 20' of corners and expansion joints. Avoid APP type at non-nailable substrates. Use SBS type with granule surfacing and polyester reinforcement as walkways.

Anchor membrane with non-ferrous termination bars and stainless steel fasteners at wall/deck transition. Termination bars to be covered with a reglet and counter-flashing even if not required by manufacturer=s warranty.

Surfacing: ceramic granule surfaced cap sheet, white in color, unless otherwise recommended.

c. EPDM (non-reinforced)
-Fully adhered

Membrane: minimum 60 mil thick EPDM non-reinforced sheet. Use tape or continuous contact adhesive seams as supplied and approved by manufacturer.

Insulation: R-20 rigid polyisocyanurate or high-density fiberboard (as part of roof manufacturer's approved system and included in the total system warranty). Polyisocyanurate will have special facers designed for EPDM adhesion and must be approved or manufactured by primary membrane manufacturer. High-density fiberboard is for overlay system to be used only under special conditions. Attach insulation with mechanical fasteners with caps that lock onto screws over metal and wood decks. Adhere with asphalt over concrete and vapor barriers. Substrate must be free of contaminants prior to membrane applications.

The insulation specified shall be compatible with the application method required and the other materials of the roofing system and shall be included in the total system warranty.

It is required that insulation be installed in more than one layer with staggered joints. Use of a recovery board is not considered a layer.

Surfacing: none; use fire rated Class A system for exterior fire resistance.

Base Flashings: 60 mil EPDM. Continue field membrane up walls and curbs. Use details that minimize uncured rubber. Anchor membrane with non-ferrous termination bars and stainless steel fasteners at wall/deck transition. Termination bars to be covered with a reglet and counterflashing even if not required by manufacturer=s warranty.

UM Standards for EPDM (listed in Table 1)

TABLE 1
UM STANDARDS - EPDM
NON-REINFORCED

ASTM Test	Property	UM
D751	Adhered membrane thickness (mils)	60
D751[1]	Mech. fasted membrane thickness (mils)	60
D412[2]	Tensile strength (psi)	1600
D412	Elongation at break (%)	500
D2137	Brittleness point (BF)	-60
D624	Tear resistance (lb-f/in)	220
E96	Water absorption (% max)	3
D573	HEAT AGING TESTS: (% original)	90
	Years as manufacturer of membrane	5
	Years company in business	5
	Number of squares installed in USA	10,000 min.
	Roof installer manufacturer approval	Required
	UL Class A	Required
	Wind uplift	FM I-90

[3]	Seaming overlap (contact cement)	3"

[1]60 mil reinforced membrane for mechanical fastened roofs.
[2]For unreinforced membrane only. Breaking strength for reinforced membrane per ASTM D751 to be 140x150 lbf (minimum).
[3]Taped seams require minimum 4" overlap.

d. CSPE (reinforced)
- Fully adhered

Membrane: minimum 45 mil thick polyester reinforced sheet. Use heat welded seams with membrane installed using continuous contact adhesive as supplied and approved by the manufacturer.

Insulation: R-20 minimum. Most insulation types are acceptable substrate (as part of roof manufacturers approved system and included in the total system warranty). Obtain written membrane manufacturer approval.

The insulation specified shall be compatible with the application method required and the other materials of the roofing system and shall be included in the total system warranty.

It is required that insulation be installed in more than one layer with staggered joints. Use of a recovery board is not considered a layer.

Substrate Board: not required

Surfacing: not required

Base Flashings: 45 mil thick CSPE or special coated metal and all as supplied and approved by roof manufacturer.

Anchor membrane with non-ferrous termination bars and stainless steel fasteners at wall/deck transition. Termination bars to be covered with a reglet and counter-flashing even if not required by manufacturer=s warranty.

UM Standards for CSPE (listed in Table 2)

TABLE 2
UM STANDARDS - CSPE
REINFORCED

ASTM Test	Property	UM
D5019	Membrane thickness (mils)	45
D2136	Low Temperature Flexibility BF	-40
D5019	Breaking strength (min. lbf)	225
D5019	Tear strength (min. lbf)	90
D5019	Ply adhesion (min. lbf/in)	10
D5019	Dimensional change %	2
E96	Water absorption (% max.)	3
	HEAT AGING TESTS:	
D750	Tensile (% original)	90
D750	Low Temperature Flexibility (% original)	90
D750	Elongation (% original)	90
	Years as manufacturer	5
	Years company in business	5
	Number of squares installed in USA	10, 000 min.
	Roof installer manufacturer approval	Required
	UL Class A	Required
	Wind uplift	FM I-90
	Heat welded seams	Required

e. PVC (reinforced)
-Fully Adhered
-Mechanically Fastened (where applicable)

Membrane: minimum 45 mil thick fabric reinforced sheet with heat weld seaming.

Insulation: R-20 minimum rigid polyisocyanurate or high-density fiberboard (as part of roof manufacturers approved system and included in the total system warranty).

The insulation specified shall be compatible with the application method required and the other materials of the roofing system and shall be included in the total system warranty.

It is required that insulation be installed in more than one layer with staggered joints. Use of a recovery board is not considered a layer.

Substrate Board: not required

Surfacing: not required

Base Flashings: special coated metal or reinforced sheet and accessories provided by primary manufacturer.

Anchor membrane with non-ferrous termination bars and stainless steel fasteners at wall/deck transition. Termination bars to be covered with a reglet and counter-flashing even if not required by manufacturer=s warranty.

UM Standards for PVC (listed in Table 3)

TABLE 3
UM STANDARDS - PVC
REINFORCED

ASTM Test	Current Standards	UM
D751	Membrane Thickness (mils)	45
D751	Breaking strength min. (lbf/in)	230
D638	Elongation at break (%)	20
D2136	Low temperature flexibility BF	-40
D570	Water absorption (% max)	2
D570	Water absorption (% max.)	3
	HEAT AGING TESTS:	
D638	Tensile (% original)	90
D638	Low temperature flexibility (% original)	80
D638	Seam strength % tensile	85
D638	Elongation (% original)	90
D2565	Accelerated weathering (hours)	7500
D1004	Tear resistance (lbf)	12
	Years as manufacturer	5
	Years company in business	5
	Number of squares installed in USA	10,000 min.
	Roof installer manufacturer approval	Required
	UL Class A	Required
	Wind uplift	FM I-90
	Heat welded seams	Required

f. Slope & Drainage

In new construction, the roof will have a minimum design slope of 1/4" per foot. In reroofing, the roof should have a minimum slope of 1/8" per foot. Tapered insulation may be necessary to achieve required slope. Use crickets, saddles and edge strips (tapered at 2 times slope) to direct water from penetrations and parapet walls.

Locate roof drains at projected low points. All roofs shall have overflow systems of either a separate and independent overflow piping system which daylights or overflow parapet scuppers.

4. Metal Roofing-Structural Standing Seam (SSR)

Structural metal roofing shall meet UL90 uplift rating. Roofing shall be pre-engineered metal running perpendicular to purlins supports and insulated by a glass batt directly beneath the roofing and over the purlins. Sheets shall have a steel or aluminum core (minimum 22 gage) and corrosion protection provided by a "Kynar" coated finish. Slope should be no less than 1" per foot. Ice guards are required on eaves over sidewalks

5. Slate

Slate material shall be Type S1 slate as specified by ASTM C406 (90-110 year performance life). Natural slate may be installed in slopes as shallow as 3" per foot, provided adhered polyethylene reinforced bitumen sheet underlay is installed (5" per foot slope is preferred minimum). Use copper nails and ridge caps. Ice guards are required on eaves over sidewalks.

Use of artificial slate requires PM approval.

6. Asphalt Shingles

Asphalt shingles shall be fiberglass seal-tab type with minimum 25-year warranty. Minimum roof slope shall be 4" per foot with one layer of 15 lb. asphalt saturated felt underlay (30 lb. at UMC) (3" per foot may be used with 2 layers of underlay). Provide a galvanized sheet steel drip edge at eaves and gable rakes. Shingles shall be nailed, not stapled.

7. Roof Deck

A registered structural engineer shall design roof decks. The design consultant shall determine expected wind uplift conditions for the building roof and determine suitability of the recommended system for these conditions.

Roof deck material shall be a minimum 20-gauge metal deck or a cast in place concrete deck. Wood or wood fiber cement decks shall not be used. Slope to drains shall be designed into the structural system whenever possible.

Concrete decks shall provide a sufficient drying period to avoid containment of residual water. Lightweight concrete shall not be used. Avoid mechanical attachment to decks/parapets. Adhesive or mop-in is preferred.

All wood curbs, blocking, subfascias, etc. should be preservative treated material.

8. Vapor Retarders

Roof consultant shall investigate and recommend whether a vapor retarder is required. Vapor retarders may be necessary when interior relative humidity is expected to rise above 45%, and the outside average January temperature is below 40°F. The vapor retarder is a layer of low permeability material to prevent moisture migration from entering the roofing system. The vapor retarder shall be installed on the warm/humidity side. Vapor retarders can consist of polyethylene sheets, laminated sheets, or multiple courses of asphalt and felts.

9. Roof Replacement

When roof replacement is necessary, it should not always require a complete removal of the existing roof. Factors in making a determination of roof replacement vs. roof overlay include:

a. Moisture content in existing insulation. If more than 20%-30% of the existing insulation is wet, total tear-off is recommended.

b. Structural analysis is required where a roof overlay results in additional imposed load on the structure. A licensed structural engineer shall confirm roof loading capacity.

c. Roofing inspection with destructive sampling. A sufficient number of at least 2" diameter core samples should be taken to verify construction of existing roof

system. These cores will indicate signs of deterioration and presence of moisture and delaminations. Core samples may also detect presence of asbestos when submitted to a laboratory for testing. Proper asbestos abatement procedures must be taken to remove this material. All holes left from the sample removal must be repaired with like materials. It is not recommended to take samples from single ply roofing systems, especially if they are still under warranty (a recover installation may require samples).

d. Condition of the existing roof surface. Proper placement of roof overlays may require the use of a substrate board for improved "U" value of roof assembly, prevention of elevation irregularities, and separation of non-compatible materials. Substrate board can prevent elevation irregularities at the board joints.

e. Suitability for attachment. A roof overlay will employ a substrate board that is mechanically attached to the deck component. If attachment cannot meet code requirements, roof replacement will be necessary.

10. Warranties & Certification

Roof manufacturer and roof installer will provide the following items:

a. The University of Missouri Roofing System Manufacturers Certification.

b. Roofing contractor [installer] will guaranty all materials furnished and work performed under the roofing system contract against defective workmanship for a period of thirty-six (36) months after final completion as provided in the construction documents. See Special Conditions for certification sample. The system may include the following components:
   (1) Roofing membrane (built-up felts or single-ply), slate, shingles, or metal roofs
   (2) Flashing and counterflashing
   (3) Insulation
   (4) Vapor barrier
   (5) Fasteners and adhesives
   (6) Sealants and caulking
   (7) Ballast and ballast stops
   (8) Walkway mats & pavers
   (9) Roof hatches, pitch pans and equipment curbs
   (10) Gutters, downspouts, and fascia panels
   (11) Roofing accessories, as required making a complete roofing system

(12) Coping

Note: Warranted roof system components are to be identified in the construction documents. Roof materials and accessories must be part of the approved system.

c. Roofing manufacturer will provide a total system warranty for the roofing system furnished under this contract against leaks and defective materials and workmanship for a minimum period of fifteen (15) years after final completion as provided in the contract. This warranty will run concurrently with the roofing contractor/installer thirty-six (36) month guaranty. This warranty will cover labor and materials for the complete roofing system and the watertight integrity and performance of the roofing system installed which includes all components identified under the roofing contractor/installer 36-month warranty. Manufacturer will be liable for full replacement cost of the roof system; therefore warranty shall be a no-dollar limit warranty. The roofing contractor or subcontractor shall provide the Owner with an Application for a Roof Warranty. Warranty shall not exclude coverage as a result of winds less than 38, 54, 63, or 72 mph (review with project manager).

d. Roofing contractor and roofing manufacturer accompanied by a designated University representative will perform, at no additional cost to the Owner, an annual inspection of the complete roofing system installation through the (36 month) contractor's warranty period. This inspection will include a written detailed evaluation of the roofing system including system failures and maintenance recommendations. All roofing system failures and defects will be repaired/corrected by the contractor at no additional cost to the Owner within thirty (30) days from date of annual inspection. These repairs/corrections will include replacing any and all wet insulation. All repairs will be approved by, and made to the satisfaction of, the Owner's representative.

e. Owner will notify roofing contractor and manufacturer, if repairs covered by the warranty are required, within twenty (20) days of discovery of defects in the roofing system. Upon written notice from the Owner of any breech of warranty during applicable warranty period due to defective material or workmanship, the affected part of parts thereof will be repaired or replaced at no cost to the Owner within thirty (30) days of receipt of notice. Contractor should notify Owners when they come on Campus for warranty repairs. Should the roofing contractor or roof manufacturer fail or refuse to make necessary repairs or replacements, when requested by the Owner, the Owner may perform, or cause the necessary work to be performed at the roofing contractor and manufacturer's expense.

f. The following are excluded from this warranty:
(1) Roof maintenance
(2) Damage to any part of the building (other than the roofing system) or to its contents.
(3) Damage resulting from any one of the following:
(a) Cracking, warping, deflection or movement of building foundation.
(b) Natural disasters such as earthquake, hail, or wind exceeding 38, 54, 63, or 72 mph (review with project manager).
(c) Accidents, vandalism, or other uncontrollable events.
(d) Chemical attacks on the membrane from sources not present at time of roofing system installation.
(e) Excessive movement or deterioration of metal components adjacent to the roof or engaged therein.

11. Roof Installation

Roofing contractor must have the following qualifications:

a. A minimum of five years experience in installation of the specified roof system.

b. Roof manufacturer certification as an installer for specified roofing systems.

c. Roof foreman and 50% of installing crew are trained and certified in the installation of specified roofing system. In addition, foreman will be full time at project site through roof completion.

4.7.3 Roofing Accessories

1. Parapet wall coping will be constructed with metal selected from one of the following materials:

a. Sheet metal, 22 or 24 gage, galvanized, factory finished with Kynar 500

b. Copper, ASTM B370, 16-20 oz.

c. Aluminum, .032" or .040", factory finished with Kynar 500

d. Stainless steel, .018 soft buff

2. Gravel stop/fascias will be aluminum, .050", and factory finished with a Akynar@ coated finish.

3. Installation will be in accordance with SMACNA minimum standards. End laps and side laps will provide for thermal expansion. Joints will have cover and backup plates.

4. Sheet metal roof accessories will be constructed with metal selected from one of the following materials:

   a. Sheet metal, 20 gage, galvanized, factory finished with Kynar 500

   b. Copper, ASTM B370, 16-20 oz.

   c. Aluminum, ASTM B209, alloy 3003, AA-C22A41 clear anodized finish, minimum 20 gage

   d. Solder, 50/50 ASTM B32

5. Surfacing aggregate shall be clean water worn opaque gravel.

4.7.4 Joint Sealers

1. The following joint sealer schedule will be reviewed and edited by the consultant and incorporated into the specifications.

JOINT SEALER	DESCRIPTION OF JOINT CONSTRUCTION AND LOCATION WHERE JOINT SEALER IS TYPICALLY APPLIED
Multi-Part Pourable Urethane Sealant	Exterior and interior joints in horizontal surfaces of concrete; between metal and concrete, mortar, stone and masonry.
Multi-Part Nonsag Urethane Sealants	Exterior vertical and horizontal joints subject to 12-2% to 25% movement including expansion joints, control joints in masonry or concrete. Sealants around window and door frames.
One-Part Acid-Curing Silicone Sealant	Exposed joints within glazed curtain wall framing system, skylight framing system, and aluminum entrance framing system. In masonry where silicone sealant was previously used.
One-Part Mildew Resistant Silicone	Interior joints in vertical surfaces of ceramic tile in toilet rooms, showers, and kitchens.
Acrylic-Emulsion Sealant	Interior joints in field-painted vertical and overhead surfaces at perimeter of elevator door frames and hollow metal door frames; and gypsum drywall, plaster and concrete or concrete masonry; and all other interior joints not subject to movement.
Foamed-In-Place Fire Stopping Sealant	Through penetrations in fire-resistance-rated floor and wall assemblies involving multiple pipes, conduits, and other items.
One-Part Fire Stopping Sealant	Through penetrations in fire-resistance-rated floor and wall assemblies involving single pipes, conduits where joint widths are narrow and of uniform width.

END OF SECTION

4.8 DOORS, WINDOWS & GLASS

4.8.1 Doors

1. Exterior doors at public entries will be aluminum, monumental grade, with medium stiles and weatherstripping, and will be insulated. All doors will have a center-locking rail. It is preferred that exterior pairs of doors have a center mullion (need for a fixed or removable mullion should be evaluated on a case by case basis). If a center mullion is not used, a stop type threshold (similar to Pemko 2005) shall be used. Kawneer 350 should be used as a standard of quality.

2. Low-usage or non-public exterior doors (mechanical areas, etc.) will be steel doors with steel frames. All steel will be minimum 16 gauge and 1 3/4" thick, galvanized, shop-primed, and painted with an epoxy or comparable paint. All steel doors and frames will be of welded construction with reinforcement at hardware locations. Steel doors will have a top channel cap, secured in place and sealed. At UMC, the backside of exterior frames shall be primed and painted with an epoxy or comparable paint.

3. Wood doors will be solid core and comply with applicable National Window & Door Association (NWDA) and Architectural Woodwork Institute (AWI) quality standards.

4. Aluminum entrances and storefronts will have thermal break construction and comply with American Architectural Metal Association (AAMA) standards. Framing will also be thermally broken from any interior construction.

4.8.2 Windows

1. Aluminum windows will have thermal break construction and will comply with American Architectural Metal Association (AAMA) standards. Framing will be thermally broken from any interior construction.

2. All operable windows will be capable of being cleaned from the interior of the building and will be supplied with a positive locking device. Screens will not be supplied with the windows. All operating mechanisms will be heavy-duty, institutional grade construction.

3. In specifying windows, consideration will be given to replacement of broken glazing. It is preferred that replacement be possible from interior of the building. Other types of replacement require PM approval.

4. At UMC, window units will comply with ASTM E283, E331, and E547. The Owner will retain the services of a testing company to perform these tests on installed window units chosen at random by the Owner. Contractor will be responsible for retesting units that fail test.

4.8.3 Glass and Glazing

1. Exterior windows and exterior glazed doors will have double glazing certified by the Insulating Glass Certification Council (IGCC).

2. All glazing in new windows, doors, storefronts, etc. will carry a ten year warranty on replacement of defective material.

4.8.4 Finish Hardware

1. All door hardware will be heavy duty or institutional grade.

2. All public areas will be served by lever-handle locksets, similar in construction and design quality to Best 93K series- 14D lever.

3. All non-public areas (mechanical, custodian, serving, etc.) will be served by knurled handle locksets, similar in construction and design quality to Best 83K series.

4. At UMC, mortise locksets will be used only in those areas requiring special security or functions. In all other areas cylindrical style locksets are preferred.

5. All locksets will accept Best Universal Lock Company 7 pin cores or cylinders. Other type locksets (electric, card access, combination, and panic devices) must have a key override function. Locksets shall be specified around Best Universal Lock Company. At UMC, Arrow and Yale may also be specified. Do not specify Falcon, Sergeant or Lockwood. Other brands require PM approval.

6. All panic devices will be touch-bar type and will have a dogging function where allowed by code. If dogging function is not allowed by code, the non-egress side of the door should be equipped with a lever handle. Rim latch type devices are preferred. If a center mullion is not allowed by code, concealed vertical rod devices are preferred. In multiple door entries, only one doorway should be keyed from the exterior. Panic devices shall be specified around Von Duprin. At UMC, Jackson may also be specified. Do not specify Sergeant or Dor-A-Matic. Other brands require PM approval.

7. Surface mounted parallel arm closers, mounted on the interior side of the opening, are preferred. All doors and frames will be reinforced at mounting locations. All screw and boltholes will be drilled and tapped. Wood doors should use thru-bolts. Floor mounted closers should not be used. Closers shall be specified around LCN 4041. At UMC, Rixon may also be specified. Do not specify Sergeant, Jackson or Yale. Other brands require PM approval.

8. Hager model #1191BB, ball-bearing type should be used as a standard of quality.

9. At UMC, all door hardware in new construction will have either US 10 or US 26D finish. In existing construction, hardware color should match existing hardware color.

10. Early in the construction document phase, the architect should discuss the combinating of the cores with the Owner. At that time it will be determined whether the Owner or the contractor will be responsible for the combinating.

11. If Owner is to do the combinating, specifications will require the contractor to supply Best 7-pin cores with two key blanks (no substitutions allowed), as required, for each lock.

    Cylinder cores and key blanks will be shipped to the Owner for installation. The contractor will provide temporary construction cores until the Owner installs permanent cores.

12. If contractor is responsible for combinating, contractor is required to use the Best Locking Systems of St. Louis to do all combinating work per the key schedule supplied by the Owner.

    The contractor will supply Best 7-pin cores and two key blanks (no substitutions allowed) to fit each core, as required for each lock. Owner will install the cores.

13. Door pulls with an offset design will not be used.

4.8.5 Power Door Operators

1. Power door operators type of operation and equipment should be as follows:

    a. Door should be operated only on demand by activation of a touch pad device. In manual mode, operators will require no more than 15 lbs. force to set in motion and 10 lbs. force to continue motion and shall provide no power assist.

b. UMC Only: The preferred activating device for exterior installations is a touchless switch mounted at 30" AFF. Switch shall be specified around P.D.E. TLS 100 Touchless Infra-Red switch with 3"-14" range adjustment and 1-10 second time delay. The preferred activating device for interior installations is a press plate switch mounted at 30" AFF. Switch shall be specified around SEDCO #59H 42@ square blue anodized plate engraved to read APress to Operate Door@. Use of other devices requires PM approval.

c. Door type should be a swinging door and must have a positive locking device for exterior and fire rated doors. Panic devices like other entry doors (supplemented with an electric strike) are preferred.

d. Inner and outer doors of vestibules should operate independently.

e. Only a single leaf of pairs of doors should have a power operator.

f. Door controls should accept electric and card access locking devices for after hour access.

g. Doors should be equipped with a keyed deactivation switch for power opener that is accessible from floor level (panic bar allows after hours egress).

h. Doors will be equipped with manufacturer=s standard signs as required by code. At UMC, the campus will provide signs.

i. Door operating equipment will be rated for heavy-duty service and must be electrical actuated (no pneumatics). All control wiring must be low voltage and compatible with building security system. At UMC, specifications should be based upon Dor-A-Matic, Besam, Horton, Stanley or Able.

j. Door operating equipment will have a two-year warranty.

k. All exceptions to these criteria (fully automatic operation, sliding doors, combined vestibule operation, etc.) must be reviewed and approved by the project manager.

END OF SECTION

4.9 FINISHES

4.9.1 Gypsum Drywall Systems

1. Use 5/8" Type X firecode drywall type construction and follow the USG gypsum board construction manual guidelines.

2. Twenty gauge (0.0329") minimum studs will be used. Specify both gauge and thickness. Wood studs will not be used.

3. Three coats of drywall finishing material (embedding, fill and finish) will be used in exposed applications. Finish coat and sanding may be omitted in concealed applications.

4. Demountable panel systems should not be used without PM approval.

5. Textured finishes will not be used on drywall ceilings.

4.9.2 Acoustical Ceilings

1. Consideration should be given to the use of ceiling tiles with non-sag warranties in high humidity or unconditioned spaces.

2. Ceiling grid will be an intermediate duty exposed grid system conforming to ASTM C635 (1" wide grid). Chicago Metallic 200 Snap Grid should be listed in the acceptable products.

   Suspend the ceiling grid directly from the building structure. Do not hang other objects from the ceiling support system. All light fixtures will be supported independently of the ceiling support system. Light fixtures, grid and other ceiling accessories will have seismic bracing.

3. At UMC, specify ceiling tiles around Armstrong Minaboard fissured tile in 2'x 4’ and/or 2'x2' size, or equal. Appearance shall be listed as criteria for equal products to allow for maintenance stock.

4. Specialty ceiling tiles/systems require PM approval.

4.9.3 Paint Finishes

1. Wall finish shall be two coats plus primer of latex eggshell or satin paint. Flat paint will not be used. Paint should be the manufacturer=s premium product. In public areas, consider semi-gloss paint on veneer plaster or concrete masonry units.

2. Ceiling finish shall be two coats plus primer of latex flat paint. Paint should be the manufacturer=s premium product.

3. Painted finish for door, window, and miscellaneous trim shall be two coats plus primer of latex or alkyd enamel semi-gloss paint. Paint should be the manufacturer=s premium product.

4. Stain finish for door, window, and miscellaneous wood trim shall be oil based stain with a urethane topcoat. A medium to high sheen/gloss should be used.

5. Epoxy paints should be two-part systems.

4.9.4 Floor Finishes

1. All vinyl composition tile will be a minimum of 1/8" thick.

2. Tile installed on slopes or inclines will be slip resistant.

3. Epoxy resin floors will be trowel applied, with a minimum thickness of 1/8" and integral curbs. Color will be integral to flooring material, not a surface coating.

4. Particular attention will be given to specification of preparation of the subfloor.

5. Ceramic tile grout should be pigmented or natural gray. White or near white grout shall not be used. Joints should be sealed with a silicone based product.

6. When specifying vinyl sheet goods, only premium products should be specified with particular attention to given surface preparation and seaming.

E. Carpet and Base

1. The preferred quality criteria is direct glue down commercial grade carpet intended for use in commercial and public spaces with construction, fire ratings, static control and appearance appropriate for this use.
2. List fire performance criteria as a submittal item.
3. Identify the manufacturer, style, and construction criteria.
   a. List manufacturer’s name and address

b. Carpet pattern: Select a pattern that has good soil hiding characteristics and the right scale for the facility. Multi-color patterns are preferred. Solid colors should be used for borders and accents only.
c. Carpet Color: Select a color that is appropriate for the facility and that has good soil hiding characteristics. Typically medium to dark colors are preferred.
d. Carpet Fiber: Specify branded nylon, type 6 or 6.6.
e. Carpet Construction: Tufted loop pile is preferred. Cut/uncut, cut and woven will be considered for specialty areas.
f. Minimum Pile Weight will be 26-oz/square yard (tufted loop) with maximum pile height of 0.20 inch.
g. Average Pile Density not less that 6000 (public areas).

4. List seaming diagram as a required submittal item.
5. Installation specification shall require the following:
   a. Extend carpet under open bottomed obstructions, under removable flanges and furnishings, and into alcoves and closets of each space.
   b. Provide cutouts where required; blind cut edges properly where not concealed by protective edge guards or overlapping flanges.
   d. Install carpet edge guard where carpet edge is exposed; anchor guards to substrate. Exposed carpet edges that abut an adjacent floor surface at a different finish or level shall be trimmed with vinyl edging approved by the Owner.
   e. Hot melt seam adhesive or similar product recommended by the carpet manufacturer, for taping seams and butting cut edges at backing to form secure seams and preventing pile loss at seams.
6. UMC only:
   a. Resilient base is preferred to be 1/8-inch thick vinyl. Joints to occur at inside corners where possible, and in no case closer than 24 inches to an external corner. Preformed corners shall not be allowed. Field fabricate corners using manufacturer recommended procedures.
   b. Wood base, from hardwood species, is acceptable with approval of Owner's Representative. Medium Density Fiberboard (MDF) is not acceptable.

END OF SECTION

4.10 SPECIALTIES

4.10.1 Visual Display & Bulletin Boards

1. Bulletin boards in public areas will be enclosed.

2. At UMC, all centrally scheduled classrooms will have chalkboards in lieu of marker boards.

4.10.2 Toilet Partitions

1. Toilet partitions will be either floor supported-overhead braced or floor and ceiling supported. Overhead braces will have anti-grip design. Wall Hung Urinal Screens will have integral wall mounting flange or continuous wall mounting bracket specified as a "Government Screen"; mounted to solid blocking in the wall.

4.10.3 Signs

1. At UMC, all new signs are typically provided by the campus. Signs specified on UMC projects will be coffee bean color background. The PM will coordinate review with the ADA Coordinator.

4.10.4 Toilet & Bath Accessories

1. Restroom toilet tissue dispenser at UMSL, UMR and UMKC will be a double row locked standard toilet tissue holder 5" in diameter that holds 2-1500 sheet rolls of tissue. An extra roll will automatically drop in place after bottom roll is used up. At least one tissue dispenser will be installed in each stall depending upon expected use of the area.

   At UMC, preferred toilet paper dispenser is a lockable dispenser constructed of stainless steel. The standard of quality is the Royce Rolls Ringer TP-4. The four roll dispenser is preferred but the designer will determine expected usage and may specify a two (2) or three (3) roll dispenser. UMC Building Services will provide the padlock for these dispensers.

2. Restroom liquid soap dispenser will have a minimal capacity of 24 ounces and have precision mode gravity feed valve that delivers a measured amount of soap at each stroke of plunger. For UMC: the preferred soap dispenser and standard of quality will be the Bobrick B-8226 pump style.

4. There will be an adequate number of paper towel dispensers for each restroom according to expected traffic flow. Towel dispensers will be of a size to accommodate 10-3/4" by 9-2" single fold paper towels. For UMC: the preferred roll towel dispenser and standard of quality will be the Howard Command 563-50.

4. Waste paper receptacles will have a minimum opening of 8" into the wall.

5. At UMC, electric hand dryers and hands free operating mechanisms for water closets, urinals, and lavatories will be used.

END OF SECTION

4.11 EQUIPMENT

4.11.1 Projection Screens

To be added later.

4.11.2 Laboratory Fume Hoods

To be added later.

END OF SECTION

4.12 FURNISHINGS

4.12.1 Window Treatments

1. Levelor Riviera horizontal mini-blinds will be used as a standard of quality.

4.12.2 Auditorium Seating

To be added later.

4.12.3 Entry Mats and Frames (UMC Only)

1. Floor mats and frames will be recessed aluminum frame with carpet type insert.

2. Carpet and backing insert will be Class 1 fire rating with a minimal pile weight of 32 ounces per square yard. Color will be from manufacturer's available standards.

END OF SECTION

4.13 SPECIAL CONSTRUCTION

To be added later.

END OF SECTION

4.14 CONVEYING SYSTEMS

4.14.1 General

1. Installing vendor will be responsible for all maintenance and service during the warranty period. Response to non-emergency service calls will be within four hours of the call. Response to emergency service calls will be within one-half hour of the call. Vendor will be financially responsible for these calls except those caused by power outages, acts of God, vandalism, and false reports.

2. All hydraulic elevators will be equipped with PVC containment piping encasing the cylinder ram and casing. Containment will be sealed at the bottom. Provide a means of testing the bottom seal and a means of evacuating any material that may enter the containment. Prevent any materials from entering the top of the containment.

3. Specification should state that the inspection and testing procedure outlined in ANSI A17.1 be conducted in the presence of the contractor, architect, Owner=s representative, and elevator consultant retained by the Owner.

4. Provide a sump hole and pump in all elevator pits. Provide an electrical outlet by the sump hole. Sump pumps shall be connected to either the storm water or sanitary sewer lines. The Owner will make final determination based on ground water conditions. Sump pumps shall be equal to Stancor elevator Pit Oil-minder control system. Size of control and pump system to be determined based on ground water conditions.

5. Hydraulic piping shall not be installed underground.

6. Elevator Pit Subdrainage:
   a. All buildings: Install waterproofing on sides and bottom of elevator pits. Waterstop all concrete joints.
   b. Buildings without an underslab drainage system regardless whether footing drains are used: Install a groundwater collection sump pit in room close to elevator pit and with the bottom of the sump pit at least 2 feet below the bottom of the elevator sump pit.
   c. Buildings with an underslab drainage system: Install the Subdrainage at an elevation below the elevator sump pit elevation.

4.14.2 Controls

1. All elevator control systems will be such that any elevator repair company is able to troubleshoot, repair, maintain, or adjust the control system. No proprietary software or

repair tools will be allowed. If an elevator control system has such software or repair tools; complete codes, tools, or other necessary means for monitoring or repairing the control system will be supplied to the Owner at time of installation. If updates or changes are required, these will also be supplied to the University at no additional cost.

2. Passenger elevators will be equipped with a fireman's recall system in accordance with ANSI A17.1, 211.3 when required. Car and hall key switches will be operated by Chicago Lock SBEXA-112-3 pin tumbler locks, combinated to the fireman service control master for the appropriate campus - Columbia: XX3835; Kansas City: XX3843; Rolla: XX3846; St. Louis: XX3852. Two (2) fireman recall system keys per elevator will be furnished.

3. Proximity type detectors will be used on elevator doors.

4. At UMC, all elevator controls and indicators shall use a vandalism-resistant design. All hall and car buttons shall be raised California Style.

4.14.3 Accessories

1. Telephone Cabinet: will be an "Elevator Phone" as manufactured by Electronic Micro Systems, Inc., 854 Chester Road, Winston-Salem, NC, 27104 (1-800-333-3671 or 1-919-765-8601), flush mount stainless steel finish (Model # PSL-V-D-Engraved). Features one-number autodialer, ringdown operation, automatic answering, intercom.

   Connect to phone line in elevator machine room. All elevator telephone equipment provided by the contractor will be compatible with the Owner's telecommunications system.

4.14.4 Finishes

1. Designer will evaluate expected use of the elevator when choosing floor covering. In areas with high student use, preferred covering is vinyl tile. If carpet is used, carpet tiles are preferred for ease of replacement.

2. All elevator lighting will be fluorescent.

END OF SECTION

4.15 MECHANICAL SYSTEMS

4.15.1 General

A. Piping General

1. All piping systems will be labeled, color coded with the type of service, (for refrigerant piping, indicate the type) and the direction of flow. Lettering will be placed at intervals of approximately 20' on straight runs of piping including risers and drops, adjacent to each valve and fitting, and at each side of penetrations of structure or enclosure. Lettering will be visible from the floor. For pipes 3/4" and smaller, permanent phenolic tags will be used. Insulated piping will be labeled as "non-asbestos." Schedule for banding and labeling of pipe and conduit will conform to ANSI A13.1.

2. All valves will be tagged with an engraved brass or plastic tag describing type of service and area controlled by the valve. Provide valve list for all valves located in the mechanical rooms.

3. Provide shut-off valves at all pipe branches and where required to facilitate partial system isolation.

4. All equipment, fixtures, or other appliances attached to any piping system will have a shut off valve located at the connection to the piping system.

5. All valves will be located with sufficient room for maintenance or replacement.

6. Manual type air vents will be installed in water systems at high points in the system.

7. Mechanical joint piping systems (Victaulic, etc.) will be used only for fire protection systems and in exposed areas for chilled water.

8. Armaflex type insulation will not be used on dual temperature piping.

9. All underground piping will have a minimum earth cover of 36" to the top of the pipe.

10. All underground piping systems will have a #12 AWG copper wire attached to the pipe for a tracing wire. Wire will be labeled and terminated in an accessible location. No splices in wire allowed. See

standard detail in appendix.

11. All underground piping systems will have a non metallic warning tape, with appropriate wording, buried 24" above the top of the pipe.

12. All insulated exterior, exposed piping will have an aluminum jacket installed to protect the insulation. Jacket will be weather-resistant, water-proof, smooth surfaced aluminum with a minimum thickness of 0.016".

13. All insulated interior piping, that is exposed in occupied areas, and is within 6' of the finished floor, will have a PVC jacket installed. This jacket will be painted to match surrounding background.

14. All insulated interior piping that is exposed in mechanical rooms, and is within 6' of the finished floor, will have an aluminum jacket installed.

15. Hanger design, application, and installation will comply to MSS SP-58 and SP-69.

16. Where initial pressure is 100 psig or greater, and when required reduced pressure requirement is 20% less of initial pressure, two stage pressure reducing stations will be used.

17. All piping systems, unless specified below, will be tested at a minimum of one and one-half times the expected working pressure, or a minimum of 100 psig and a maximum of the design pressure of the pipe and fittings. Test all systems for a minimum of four hours. When test pressure exceeds 125 psig, test pressure will not exceed a value which produces a hoop stress in the piping greater than 50% of the specified minimum yield strength of the pipe.

    a. Natural gas: test at twice the working pressure or a minimum of three psig.

    b. Sanitary sewer: test at 10' of head pressure for no less than four hours.

    c. Sprinkler systems: tested at a minimum of 200 psig for no less than four hours.

18. Water piping systems will be cleaned according to AWWA M23.

19. All solder will be lead free.

B. Piping Penetrations

1. All penetrations of foundation walls will be leak proofed.

2. All penetrations, except steam tunnels, will be individual pipes or conduits. Groups of pipes or conduits in a common penetration will not be allowed.

3. Minimum strength of pipe penetrating foundation walls will be equal to Schedule 40.

4. All penetrations, except steam, steam condensate, or other high temperature piping, will be waterproofed in the following manner:

   a. For new construction, the foundation wall will have a steel sleeve installed that is 2" larger in diameter than the conduit to be installed. For existing construction, the hole will be core drilled. In multiple duct situations, sufficient space will remain between the penetrations to maintain the structural integrity of the foundation wall.

   b. A rubber seal, equal to Link-Seal, will be installed in the space between the conduit and the sleeve or drilled hole, near the interior surface of the foundation wall. The same space will have waterproofing installed on the exterior side of the rubber seal.

5. The point of attachment for steam tunnels will have a concrete, cast-in-place transition, with waterstopping material cast into the concrete. The waterstopping will be embedded into the foundation wall according to the manufacturer=s recommendations. Waterstopping material will be equal to Volclay RX-102.

6. Individual penetrations of steam and condensate lines will be installed as follows: The foundation penetration will be an anchor point and shall be reviewed by a structural engineer. The penetration will be sleeved with a steel sleeve at least 6 inches beyond the penetration. A flange will be welded to the sleeve and to the pipe on the interior side of the foundation wall with a continuous, waterproof weld. The exterior side of the penetration will have waterproofing material applied.

4.15.2 Building Plumbing Systems

A. General Guidelines

1. Thermometers and gauges

a. All thermometers and gauges will have dial faces between 2" and 5" in diameter. All thermometers installed more than 8' from floor level will have a minimum dial face of 4" and will be installed to allow reading from floor level.

b. All thermometers will be of the dry well type. All thermometers will be installed with thermal conductive material in the dry wells.

c. All thermometers and gauges will be selected with expected operating conditions near the middle of the range of the device.

d. Thermometers and pressure gauges will be accurate to 1% of full scale.

e. All gauges will be installed with gauge cocks.

B. Domestic Water Systems

1. Materials

a. No PVC piping will be used for domestic water systems.

b. All pipe and fittings, 3" and smaller, will be copper, Type L, hard or soft drawn for solder joint connections, ASTM B88. All solder will be lead-free. For pipe sizes larger than 3", galvanized pipe and fittings may be used.

c. Unions 2-1/2" and larger will have flange joints.

f. Valves

(1) Gate valves, 4" to 12", will be flanged, cast iron, 125 lb., solid wedge, bolted bonnet, OS&Y, Nibco F617-0 or equal. Gate valves 4" and smaller will not be used. UMC Only: no gate valves will be used in the building.

(2) Check valves 2" and smaller will be soldered, bronze, 125 lb., horizontal swing, Nibco S-413 or equal. Check valves 2-1/2"

to 8" will be flanged, cast iron, 125 lb., bolted bonnet, horizontal swing, Nibco F-918 or equal.

(3) Ball valves, 3" and smaller, will be soldered, bronze 125 lb., full port, Nibco S-580 or equal.

(4) Butterfly valves, 6" and larger, will be gear operated.

(5) Globe valves will be 2" and smaller.

(6) Strainers, 2" and smaller, will be threaded, bronze, 250 lb., 20 mesh stainless steel screen, Watts Model 777 or equal. Strainers 2-1/2" to 12" will be flanged, cast iron, 125 lb., .045" perforated stainless steel screen, Hoffman Model 450 or equal.

(7) Low point drain valves will be equipped with a hose adaptor fitting.

2. Water softeners

a. UMC Only: specifications for water softening equipment should be based on Water Rite.

3. Backflow preventers

a. All backflow preventers will be reduced pressure principle devices approved by Missouri Department of Natural Resources.

C. Sanitary Waste and Vent

1. Materials

a. Pipe and fittings may be cast iron, DWV copper, or DWV Schedule 40 PVC. Copper and PVC may be used above grade only. Cast iron may be either hubbed or no-hub. All piping systems will be designed for the intended use.

b. Floor drains

(1) All floor drains in mechanical rooms and janitor closets will have a minimum pipe size of 3", a minimum strainer size of 6½", and have a removable strainer.

D. Storm Sewer Systems

1. Pipe and fittings may be cast iron, or DWV schedule 40 PVC. Piping below building floor slabs to 5' outside the building wall will be cast iron.

2. Provide cast iron year cleanouts at grade with a concrete pad.

E. Special Systems

1. Acid waste

a. Pipe and fittings may be either Duriron, glass, or plastic. All materials must be rated and approved for acid waste use.

2. Distilled and deionized water

a. Pipe and fittings will be Schedule 80 PVC or other plastic piping systems designed specifically for this type of service.

3. Natural gas

a. Pipe and fittings will be carbon steel, A53 Gr. B or A106 Gr. B, Schedule 40.

b. Valves 1" and smaller will be ball valves, rated for the type of service.

4. Compressed air and vacuum

a. Pipe and fittings will be Type L.

F. Fixtures

1. All fixtures and related equipment will be of commercial grade or better.

2. Plumbing fixtures

a. All fixtures (sinks, urinals, water closets, etc.) will be white in color.

b. All fixture hardware (faucets, flush valves, etc) will be chrome color.

c. Pop-up drain stoppers will not be specified for sinks. Strainers only will

be installed (exception: residence halls)

d. All water closets will have check hinges.

e. On applications having automatic faucets, infrared proximity sensor type will be used. Spring return valves on faucets shall not be used.

f. UMC Only: all faucets, urinal flush valves, and water closet flush valves will be automatic. Battery operation is preferred. Flush valves will have a manual override function. Sloan, Zurn or Delaney are acceptable manufacturers.

g. All showers will have anti-scald mixing valves.

4.15.4 FIRE PROTECTION SYSTEMS

A. Sprinkler Systems

1. Materials

a. All materials will comply with NFPA.

b. Minimum Schedule 40 for piping. UMC Only: Schedule 10 piping with Victaulic Firelock rigid rolled groove fittings is allowed.

c. If mechanical joint systems are used, fittings will be equal to Victaulic 005 Firelock Rigid rolled grooved fittings. No cut grooves or O-ring type socket fittings will be allowed.

d. All underground piping will be C900 with ductile iron fittings. Fittings will be coated and wrapped with polyethylene per AWWA C105.

4.15.5 REFRIGERANT COOLING SYSTEMS

A. Material

1. All piping and fittings will be copper except in an evaporative condenser, where steel piping is acceptable. Use Long radius fittings.

2. All solder will be 15% silver solder except on connections to expansion valves, sight glasses, and driers where Starbrite solder is acceptable.

B. Equipment

1. Compressors

a. All compressors will be supplied with a five (5) year warranty.

b. Multiple units are preferred over larger single units.

c. All compressors will be single speed.

d. All three (3) phase units will have adjustable voltage monitors for each phase, with manual reset.

e. Provide recycle timers and crankcase heaters with all compressors.

f. Provide high and low pressure switches.

2. All solenoid valves will have a manual lift stem.

3. Provide driers on all liquid lines with isolation valves on each side of the drier.

4. Condensing units, if designed to operate at less than 55°F, will be provided with hot gas bypass and with condenser fan cycle control operated from the head pressure.

5. All coils will have copper tubes and aluminum fins.

4.15.6 WATER COOLING SYSTEMS

A. Chilled Water Loops

1. Material for chilled water loops will be PVC C900, class 150 piping only, with ductile iron fittings encased in polypropylene . Insulation will be provided where chilled water lines pass close to steam lines.

2. All fittings will be installed with UL listed and approved retainers. Thrust blocks are not desired.

3. Isolation valves will be installed for each building service. The isolation valve will be a gate valve, installed with a valve box, located as close as practical to

the main line.

4. All loop systems will be provided with a means of air relief at all high points. The preferred method for air relief is a manually operated ball valve located underground in a meter box or similar enclosure.

5. All building service piping will have a strainer and chilled water meter installed at the point of entry into the building. UMC Only: EMO will supply specifications for the water meter.

B. Interior Chilled Water Systems

1. Piping

a. PVC will not be used for chilled water systems above ground.

b. Welded steel systems will use black steel piping and fittings, ASTM A53, Schedule 40. Minimum pipe size will be 3/4".

c. Copper systems will use a minimum of Type L copper.

d. Any threaded black steel pipe shall be schedule 80.

2. Valves

a. Control valves, for pipe sizes 3" and smaller, will be globe valves. For pipe sizes larger than 3", control valves will be butterfly valves.

b. Isolation valves, for pipe sizes 2" and smaller, will be ball valves. For pipe sizes larger than 2", isolation valves will be butterfly valves.

c. Balancing valves 2-1/2" and smaller will be plug valves. For pipe sizes larger than 2-1/2", butterfly valves will be used.

d. Butterfly valves will be resilient seated with bronze or stainless steel discs and will be bubble-tight. All butterfly valves will be lug-type and gear operated.

3. Insulation

a. All insulation will be either fiberglass, flexible unicellular foam, or cellular glass.

4. Stand alone chilled water systems will have a fill and make-up connection installed. A backflow preventer will be installed at each location. The connection will be sized to allow the filling of the system in approximately four hours.

5. Stand alone chilled water systems will have an air separator installed.

C. Condenser Water Systems

1. Material: Schedule 80 PVC or high temperature (180°F). Fiberglass piping will be used at UMC Only. Steel piping may be used upon approval at UMSL, UMKC, and UMR. Steel fittings or stainless steel (Schedule 10) fittings will be used at absorption chillers and pumps.

D. Equipment

1. Cooling Towers

a. If year around operation is desired, a dry-basin type tower is preferred over sump heaters.

b. Gravity flow distribution systems are preferred.

c. All hot water basins will have easily removable covers.

d. A five-year warranty will be provided with each cooling tower.

e. All cooling towers must have CTI certified performance.

f. All fans will be gear/shaft driven with the motor located outside the air stream. No belt driven fans will be allowed. Designer will evaluate the use of 2-speed or variable speed fans. All variable frequency drives will be installed with a bypass switch. UMR Only: Variable frequency drives are desired on all cooling towers.

g. All cooling towers will have extended lubrication lines.

h. All cooling towers will have vortex breakers installed on cold water sumps.

i. Roof mounted cooling towers that are elevated above the surrounding grade will have deck installed around the perimeter of the tower.

j. Provisions will be made for complete tower drain down, ladders and walkways will be installed to allow access to tower fans, motors, gear boxes, etc.

k. Aesthetic qualities of any tower being located in public view will be evaluated. In most cases, screens will be required around cooling towers.

l. Galvanized towers nor galvanized metal within the tower will be allowed.

m. Support systems will be coated steel.

n. Designer will consider efficiency losses over time when sizing the cooling tower for a chiller.

2. Chillers

a. A hand-off-auto switch will be provided to allow local control or Energy Management Control System (EMCS) control. All control panels will be provided with interface capabilities for connection to the EMCS for demand control and chilled water reset. UMC Only: Chiller controls will be digital type controls. For systems larger than 100 tons, controls will be integrated with the building EMCS.

b. Provide thermometers and pressure gauges for entering and leaving condenser and chilled water and bypass lines. Thermometers will be 6" dial type. Mercury thermometers are not allowed in this application.

c. Provide hour meters on electric chillers.

d. UMC Only: Owner will provide specifications for flow meters required for chilled water and condenser water.

e. Consideration will be given to sound attenuation when designing the location and installation of a chiller.

f. Condensate coolers will be used on absorption chillers.

g. All pipError! Bookmark not defined.e connections to chillers will be flanged.

h. All cold sections and lines will be insulated.

3. Pumps

a. All pumps will have mechanical seals. Pumps 7 1/2 horsepower and greater will have mechanical split seals. A standard of quality for mechanical split seals is Chesterton.

4. Expansion tanks

a. All expansion tanks will be located on the suction side of pumps and will be diaphragm type.

5. All condensing water systems will have stainless steel strainers installed.

6. Controls

a. All equipment will have a hand/off/auto switch installed to allow manual override of the normal controls.

b. Chiller controls will be digital and will include the capability to interface with the EMCS for chilled water reset, demand limiting, and remote start/stop.

4.15.7 STEAM & HOT WATER HVAC SYSTEMS

A. Distribution (Steam)

1. Pipe and fittings

a. All piping will be black steel. Supply piping 2" and smaller will be schedule 80. Supply piping larger than 2" will be schedule 40.

b. Fittings 2 1/2" and smaller will be threaded only for appendages. Fittings for general piping will be welded. Fittings 3" and larger will be welded, with flanged connections to valves and equipment. All fittings will be forged steel.

2. Valves 2 1/2" and smaller will be threaded OS&Y gate valves, 800 lb. class. Valves 3" and larger will be flanged, cast steel, OS&Y, 150 lb. class.

3. Strainers will be forged bodied of 800 lb. class.

4. Traps will be cast iron bodied of 250 lb. class. A cooling/storage chamber will be installed with each trap.

5. All pipe guides will be axial, full circumference, "spider" type.

6. All anchors will be fully welded to the pipe and will be located in manholes or other accessible spaces whenever possible.

7. All anchors, guides, and other metal accessories will be constructed of galvanized or painted metal, and will not be mounted on the floor of manholes or chases. All support systems will be wall mounted.

8. All expansion joints will be grease pack type. UMC Only: Use externally pressurized bellows type for expansion joints..

9. All drip legs will be a minimum of 12" above the floor.

10. All items requiring maintenance will be located to allow ease of access.

11. All condensate mains will have float-type automatic air vents, 250 lb. class, located at the high points of the system. All air vents will be easily accessible.

12. Insulation

a. All steam and condensate lines will be insulated.

b. Owens-Corning "Foamglass" will be used as a standard of quality.

c. Jackets of .020" smooth surfaced aluminum will be installed in accessible areas. Insulation in non-accessible areas will not have a jacket installed.

13. Steam chases

    a. Steam chases will be constructed of "U" channel, reinforced concrete. Weatherproofing will be provided between sections of the chase.

    b. Floor of the chase will have a continuous drain trough that is a minimum of 2" deep and 6" wide. The chase will be graded to provide drainage of this trough to the manholes. Nothing will be allowed to obstruct this drain trough.

    c. The lid for steam chases will be pre-cast, reinforced concrete, that is notched over the "U" channel walls to prevent movement. Lifting eyes or lugs will be provided. Weatherproofing will be installed at the joints between lid and chase walls and between adjoining lids. A weatherproofing system over the top of the chase will be installed.

    d. Soil compaction beneath steam chases will be a minimum of 95% of maximum density at optimum moisture content (+2%), standard proctor. Excavation to undisturbed soil is not considered sufficient. Compaction to the sides and above a chase is dependent on the area. If chase is passing beneath a paved area, above conditions will apply. If chase is passing beneath a landscaped area, soil will be compacted to 88-92% of maximum density.

    e. All supports will be wall mounted. Nothing will be supported from the floor of the chase.

    f. When a steam chase crosses another utility line, a minimum clearance of 6" will be maintained and a minimum of 2" of insulation will be installed between the chase and other utility.

    g. When a steam chase is routed through landscaped areas, the top of the chase will be a minimum of 3' beneath the surface. Designer will evaluate the need for insulation to protect plantings.

14. Manholes

    a. All manholes will be constructed of reinforced concrete.

    b. All penetrations will be sealed.

c. All manholes will have a sump with a minimum size of 2' x 2' x 2'. Gravity drainage of the sump is preferred. French or siphon drains are not allowed.

d. A pump will be installed where gravity drainage of the sump is not possible. UMC Only: pump will be supplied by the Energy Management Office and installed by the contractor. A dedicated electrical circuit will be provided for the pump. Discharge piping will be copper and will include a check valve, union, and a shut off valve.

e. Where electricity is supplied to a manhole, a separate circuit, with a duplex receptacle will be installed for maintenance. All electrical wiring will be installed in a rigid conduit.

f. One piece ladders will be used. Individual rungs mounted to the wall are not acceptable. All ladders will be welded carbon steel that is hot dipped galvanized. Rungs will be non-slip, 3/4" diameter on 12" centers.

g. Manhole lids will be sized for any equipment in the manhole but will be no smaller than 32" in diameter. The lid will not be fastened. All manhole covers and frames will be cast iron. A standard of quality is the Neenah R-6080 with solid cover. All covers will be imprinted with the word "STEAM".

h. A vent hole with a solid lid will be provided in each manhole. Minimum size is 12" in diameter. All vent covers and frames will be cast iron. A standard of quality is the Neenah R-6007 with type F underside hooks for locking.

i. Provide steam and condensate meters at the building entrance.

B. Medium and Low Pressure Steam (Above grade)

1. Pressure Reducing Valves (PRV)

a. Spence is the preferred brand of valve and will be used as a standard of quality. Other acceptable brands are Dunham/Bush and Spirax/Sarco.

2. Pipe and fittings

a. All piping will be black steel. For supply, piping will be Schedule 40. For condensate, piping will be Schedule 80.

b. Fittings 2" and smaller will be threaded cast iron or malleable iron. Fittings 2 1/2" and larger will be welded, with flanged connections to valves and equipment.

3. Valves 2" and smaller will be 150 lb. rising stem gate valves with a union on one side. Valves 2 1/2" and larger will be OS&Y gate valves. Globe valves will be used only for throttling purposes. Globe valves will be a minimum of 150 lb., and will be rated for steam.

4. All traps will be protected by a strainer upstream. Isolation valves will be installed on each side of each trap with blowdown. No integral check valves will be used.

5. Strainers will be Y-pattern, rated for steam, with stainless steel baskets. All strainers will be installed with a blow down valve.

6. Safety relief valves will have piping equal to or larger than tappings of the valve. Discharge will be piped to a safe point. It is preferred the discharge be piped to exterior of the building. Do not connect vent lines from pressure powered pumps or condensate pumps to a relief vent pipe.

7. Closed cell foam insulation will not be used.

8. All piping exposed in occupied areas, and is within 6' of the finished floor, will have an aluminum jacket installed. PVC will not be used for this jacket.

9. Heat exchangers will be ASME approved and will be installed with relief valves, rated for the service, on both steam and hot water systems. Locate heat exchangers to allow removal of the bundle. Install gauges and thermometers to indicate the following: pressure of entering steam, pressure and temperature of entering water, and pressure and temperature of leaving water. Install expansion tanks on the water side of all heat exchangers with a sight glass and provisions for draining and venting.

10. All coils will be tube-in-tube, non-freezing type with a minimum 1" O.D. tubing. Designer will consider the use of integral face and bypass coils, especially in situations using steam to pre-heat outside air. Provide two steam traps with

bypass for all pre-heat coils.

11. Steam humidifiers will be equipped with normally closed controls to automatically shut off the steam supply during the cooling season.

12. Air vent/vacuum breakers will be installed on steam equipment as required.

13. Pressure powered pump (UMC Only)

    a. Pump shall be a pressure powered design, using 60 psig steam to pump low pressure steam condensate.

    b. Pump shall be constructed with a cast iron body, designed for maximum operating pressure of 125 psig at 450°F. Pump shall include bronze or stainless steel check valves on the inlet and outlet, and connections for high pressure steam and vent. All connections shall be threaded or flanged. The pump shall contain a float operated snap acting mechanism to actuate fill and discharge cycles. All internal components shall be stainless steel.

    c. Pump shall be equipped with a gage glass with brass cocks and manufacturer furnished insulating jacket.

14. Pressure powered pump/receiver: provide a condensate receiver inlet reservoir of welded steel construction, mounted above the pump and sized in accordance with the manufacturer's recommendations for the pump capacity. Condensate receiving tank shall have a drain installed.

C. Hot Water

1. Pipe and fittings may be either black steel or copper. Steel should be as described herein. Copper will be Type L and will be 3" or smaller.

2. All hot water piping will be insulated.

3. Pumps

    a. Bell and Gosset will be used as the standard of quality.

    b. Horizontal in-line pumps will have a maximum of one horsepower. Vertical in-line pumps will have a maximum of five horsepower, be mounted

within 4' of the floor, and will be protected by a strainer. It is preferred all in-line pumps be close-coupled.

4.15.8 AIR HANDLING SYSTEMS

A. Air handling units

1. All units will have a magnahelic type filter pressure differential indicator installed with a manifold and valves to isolate lines to each side of the filter.

2. Thermometers will be installed to show temperatures of the mixed, discharge, outside, and return air. Thermometers will be bi-metal type with a minimum dial face of 4".

3. All oil and grease lines will be extended to the exterior of the case.

4. All drain pans will be stainless steel, externally insulated and bottom drained. Provisions for cleaning will include either a removable pan or ease of access for cleaning in place. Traps for drain systems will be sized for the system served. Ensure adequate room for the size of trap required. Adjust the height of the housekeeping pad as required. A 6" minimum height housekeeping pad is preferred.

B. Coils

1. All coils will have a minimum of .025" tube wall thickness and 5/8" O.D. minimum diameter.

2. It is preferred hot water only coils have a maximum of 8 fins/inch. Dual temperature coils are preferred to have a maximum of 10 fins/inch.

3. All coils will have copper coils, aluminum fins, and non-ferrous headers.

4. Coils will be drainable.

5. All water coils will be piped for counter flow.

6. Balancing valves will be installed at the coil.

C. Dampers

1. All dampers that will be used in a fully closed position will be low-leakage type. A standard of quality is Ruskin CD60.

D. Fume Hoods and Laboratory Systems

1. 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 uses of a particular system.

2. Fume Hoods

a. The standard of quality for fume hoods is Kewaunee Air Flow Supreme.

4.15.9 CONTROL SYSTEMS

A. Equipment

1. Air compressors

a. All air compressors shall have the following features:
(1) Crankcase shall be one piece construction. A crankcase with separate, removable oil pan will not be acceptable.
(2) Valve assemblies shall be disc and spring type which do not require the removal of the head for replacement. Reed type valves will not be acceptable.
(3) Crankshaft bearings shall be tapered roller type and shall be serviceable without disassembly of the unit. Journal type bearings will not be acceptable.
(4) An oil sight glass shall be provided for visual verification of oil level.
(5) Reciprocating air compressors shall be sized with respect to their motor horsepower requirements.
(6) Auto tank drains and hour meters.
(7) Do not mount air dryers on compressors and/or tanks.

b. Duplex air compressors
(1) Provide tank mounted duplex type air compressor. Compressor shall be two-stage reciprocating oil lubricated

suitable for use in a pneumatic control system.

(2) Equip air compressor unit with the following:
- Low resistance intake air filter
-A rated ASME relief valve
- High-pressure ASME horizontal storage tank, with drain test cock
- Automatic alternator to equalize running time of each motor
- Magnetic starters with overload protection and on/off switch
- Belt guards. UMC only: No Belt guards.
- Refrigerated air dryer sized to reduce dew point of control air supply to 38°F (3.3°C) at 100 psig pressure with an inlet temperature of 180°F (82.2°C)
- Coalescing filter with replaceable filter cartridge, equipped with differential pressure indicator and auto drain mechanism
- Include hour meters on each unit to track run time.

c. Simplex air compressors

(1) Provide tank mounted high-capacity air compressor. Compressor shall be two-stage reciprocating oil lubricated suitable for use in a pneumatic control system.

(2) Equip air compressor unit with the following:
- Low-resistance intake air filter
- High-pressure tank relief valve
- High-pressure ASME horizontal storage tank with drain test cock
- Belt guards
- Unit mounted air cooled aftercooler
- Provide refrigerated air drier to reduce dew point of control air supply to 38°F (3.3°C) at atmospheric pressure
- Coalescing filter with replaceable filter cartridge, equipped with differential pressure gauge and auto drain mechanism.

2. Install gauges on all input and output control signal lines at the controller.

3. Sensors

a. All electronic temperature sensors will be 1,000 ohm platinum, resistance temperature detectors (RTDs) with two (2) wire connections.

Install using thermo-conductive material in thermo wells.

b If application requires a humidity sensor, a high quality unit should be specified. Hy-cal can be used as a standard of quality.

c Differential pressure switches, if used for fan status on VAV applications, will not be Barber-Coleman PC301. All units used will be repeatable, reliable, and adjustable.

d Air flow stations will be used to measure outside air on all systems. These stations will be averaging grid type with 90% accuracy that comply with ASHRAE standards for duct traversing.

e Freeze-stats will be sized and configured to provide accurate averaging for the coil and will have a manual reset.

B. Control tubing and wiring

1. UMKC, UMR, and UMSL: Control tubing will be seamless copper tubing, Type K or L, ASTM B88,or polyethylene non-metallic tubing, ASTM D2737. Polyethylene non-metallic tubing will be run within adequately supported rigid enclosure, such as metallic raceways, EMT, or PVC pipe. All tubing will be supported directly from the building structure with supports at a maximum of 6' on center. Control tubing will be routed through conditioned spaces. If such routing is not possible, the system will be supplied with air dryers and drip legs.

2. UMC Only: all tubing will be hard drawn copper except within 2' of a device, where poly tubing may be used. All tubing will be supported directly from the building structure with supports at a maximum of 6' on center. Control tubing will be routed through conditioned spaces. If such routing is not possible, the system will be supplied with air dryers and drip legs.

3. All control wiring for binary inputs and outputs in control panels will be #12 or #14 stranded wire.

C. Sequence of Operation (for UMC Only):

1. The following sequences of operation are to show our preferred controls for a typical system. Where the designer determines these are not appropriate for a specific design, these may be changed. However, every effort will be made to comply with the intent of these arrangements.

2. 100% outdoor air systems

a. Typical equipment list, in order from outside air intake to exhaust.

(1) Supply air duct
- Outside air sensor
- Outside air damper, NC, 2 position
- Filter rack
- Air flow monitor
- Heat recovery coil
- Heat recovery discharge air temperature sensor
- Steam pre-heat coil w/ NO 2 position valve and NO modulating valve
- Supply fan
- Pre-heat coil discharge temperature sensor
- Freeze-stat, manual reset
- Chilled water coil, NC modulating valve, antifreeze pump
- Cooling coil discharge temperature sensor
- Heating coil, NO modulating valve
- Humidifier, steam NC modulating valve, NC 2 position valve
- Heating coil discharge temperature sensor
- Smoke detector

(2) Occupant zone
- Occupant override
- Humidity sensor
- Temperature sensor

(3) Exhaust air duct
- Smoke detector
- Air flow monitor
- Heat recovery coil
- Exhaust fan

b. Typical point list

(1) Analog inputs
- Outside air temperature
- Heat recovery discharge temperature
- Pre-heat discharge temperature
- Cooling coil discharge temperature
- Heating coil discharge temperature
- Zone temperature

- Zone humidity
- Supply fan air flow
- Exhaust fan air flow
- 3 heat recovery loop temperatures

(2) Binary inputs
- Supply fan status
- Exhaust fan status
- Heat recovery pump status
- Occupant override

(3) Analog outputs
- Supply fan speed
- Exhaust fan speed
- Pre-heat modulating valve
- Chilled water valve
- Hot water valve
- Humidifier valve
- Heat recovery loop valve

(4) Binary outputs
- Supply fan start/stop command
- Exhaust fan start/stop command
- Heat recovery pump start/stop command
- Pre-heat 2 position valve
- Humidifier 2 position valve
- Anti-freeze pump
- Outside air damper

(5) Direct connected safeties
- Freeze-stat
- Supply fan smoke detector
- Exhaust fan smoke detector
- Outside air damper
- Pre-heat 2 position valve
- Outside air damper limit switch
- Supply fan
- Exhaust fan

c. Safety and shutdown features

(1) All safety shut downs will be hardwired into the system.

(2) In the event of a smoke alarm signal from either smoke detector (exhaust air duct or supply air duct), the supply and exhaust air fans will shut down and the outside air dampers will close.

(3) A manual reset freeze-stat on the upstream face of the cooling coil will stop supply and exhaust air fans, close outside air dampers and open the modulating preheat valve.
(4) An outside air damper limit switch will stop supply and exhaust fans when dampers are not open.
(5) The two (2) position humidifier valve will be closed upon shut down of supply air fan.
(6) For VAV systems, a manual reset high limit static pressure sensor will be located in the discharge ductwork near the fan discharge. It will shut down the supply air fan whenever static pressure is greater than the set point.

d. Occupied/Unoccupied cycle
(1) Occupied/unoccupied cycle for the AHU will be determined by the controller scheduling program.
(2) During occupied cycle, the fans runs continuously. During the unoccupied cycle, the fans are off, outside air damper is closed and preheat coil remains in control.
(3) During the unoccupied cycle, a zone temperature sensor will enable the AHU system if the zone setback set point is reached.
(4) All systems will have an occupant override button located in the occupied zone.

e. Preheat control
(1) With the outside air below 55ºF, the preheat valve modulates to maintain preheat discharge air temperature set point.
(2) With the outside air below 35ºF, the two (2) position preheat valve opens. The valve is sized for 10 ºF rise at full air flow.
(3) With the outside air above 55ºF, preheat valves will be closed.

f. Static pressure control for VAV systems
(1) The controller will maintain the static pressure set point in the supply air ductwork by varying the speed of the fans.
(2) Ramp functions will be accomplished in the variable frequency drive controls, not in the EMCS controller software.
(3) Building pressure will be maintained by matching supply air and exhaust air flows, as measured by flow monitoring stations.

g. Chilled water coil control
(1) In the cooling mode (OA>55ºF), the controller will maintain cooling coil discharge air temperature set point by modulating

the cooling coil valve.

(2) In the dehumidification mode (OA>55ºF & Zone RH >60%), the controller will maintain the dehumidification set point by modulating the cooling coil valve.

(3) In the heating mode (OA<55ºF), the controller will shut the cooling coil valve.

(4) When OA<35ºF, the antifreeze pump will be energized.

h. Heating coil control

(1) In the dehumidification mode (OA>55ºF & Zone RH >60%), the controller will maintain the discharge air temperature set point.

(2) In the heating mode (OA<55ºF), the controller will maintain the heating coil discharge air temperature set point by modulating the heating coil valve.

i. Humidifier control

(1) In the cooling mode (OA>55ºF), the controller will shut the modulating humidifier valve and the 2 position valve. The 2 position valve will be used to stop the flow of steam to the steam jacket and humidifier.

(2) In the heating mode (OA<55ºF), the controller will maintain the humidification set point by modulating the humidifier valve. The 2 position valve will open.

j. Heat recovery control

(1) Energize the heat recovery system when the outdoor air temperature is below 50ºF or above 80ºF.

3. Mixed air systems

a. Typical equipment list, in order from outside air intake to exhaust.

(1) Supply air duct

- Outside air sensor
- Outside air damper
- Air flow monitor
- Return air inlet w/ damper in cross connection
- Filter rack
- Supply fan
- Mixed air temperature sensor
- Heating coil, NO modulating valve

- Heating coil discharge temperature sensor
- Freeze-stat, manual reset
- Chilled water coil, NC modulating valve, antifreeze pump
- Cooling coil discharge temperature sensor
- Smoke detector

(2) Occupant zone
- Occupant override
- Temperature sensor

(3) Return air duct
- Return air temperature sensor
- Smoke detector
- Return air fan
- Cross connection to supply air duct
- Exhaust air damper

b. Typical point list

(1) Analog inputs
- Outside air temperature
- Mixed air temperature
- Cooling coil discharge temperature
- Heating coil discharge temperature
- Zone temperature
- Outside air flow
- Return air temperature
- Supply air static

(2) Binary inputs
- Supply fan status
- Return fan status
- Occupant override

(3) Analog outputs
- Supply fan speed
- Return fan speed
- Chilled water valve
- Hot water valve

Outside air damper
- Return air damper
- Exhaust air damper

(4) Binary outputs
- Supply fan start/stop command
- Return fan start/stop command
- Anti-freeze pump

(5) Direct connected safeties
- Freeze-stat
- Supply fan smoke detector
- Return fan smoke detector
- Outside air damper
- High fan static
- Supply fan
- Return fan
- Hot water valve

c. Safety and shutdown features
(1) All safety shutdowns will be hardwired into the system.
(2) In the event of a smoke alarm signal from either smoke detector (return air duct or supply air duct), the supply and return and exhaust air fans will shut down and outside air dampers will close.
(3) A manual reset freeze-stat on the upstream face of the hot water heating coil will stop the supply, return and exhaust air fans, close outside air dampers and open the modulating heating valve.
(4) For VAV systems, a manual reset high limit static pressure sensor will be located in the discharge ductwork near the fan discharge and shut down the supply air fan whenever static pressure is greater than the set point.

d. Occupied/Unoccupied cycle
(1) Occupied/unoccupied cycle for the AHU unit will be determined by the controller scheduling program.
(2) During occupied cycle the fans runs continuously. During the unoccupied cycle, fans are off, outside air damper is closed and heating coil remains in control.
(3) During the unoccupied cycle, a zone temperature sensor will enable the AHU system if the zone setback set point is reached.
(4) All systems will have an occupant override button located in the occupied zone.

e. Heating coil control
(1) In the heating mode (OA<55ºF), the controller will maintain heating coil discharge air temperature set point by modulating the heating coil valve.
(2) In the cooling mode (OA>55ºF), the controller will shut the

heating coil valve.

(3) For single zone systems, zone temperature will be used to control discharge temperature.

(4) For systems supplying more than one zone, discharge air temperature will be reset based on outdoor air temperature.

f. Chilled water coil control

(1) In the cooling mode (OA>55ºF), the controller will maintain cooling coil discharge air temperature set point by modulating the cooling coil valve.

(2) In the heating mode (OA<55ºF), the controller will shut the cooling coil valve.

(3) When OA<35ºF, the antifreeze pump will be energized.

(4) For single zone systems, zone temperature will be used to control the discharge temperature.

(5) For systems supplying more than one zone, the discharge air temperature will be reset based on outdoor air temperature.

g. Outside air control

(1) When OA<65ºF, modulate outside air, return and exhaust air dampers to maintain discharge air temperature set point.

(2) When OA>65ºF, maintain minimum outside air position.

(3) Air flow monitor will be used to control minimum outdoor air position.

(4) When no chilled water is available and when outside air is 5ºF less than return air, open outside air and exhaust air dampers to cool and ventilate occupied zones.

(5) When a CO2 monitor is used, maintain the return air set point through a point interface device loop by modulating outside air, return air, and exhaust air dampers.

h. Static pressure control for VAV systems

(1) The controller will maintain the static pressure set point in the supply air ductwork by varying the speed of the fans.

(2) Ramp functions will be accomplished in the variable frequency drive controls, not in the EMCS controller software.

4.16 ELECTRICAL

4.16.1 Distribution Systems

A. Duct Bank Systems (concrete encased)

1. All duct banks will have a minimum of 36" of earth cover.

2. Duct will be type DB Schedule 40 or 80 PVC. In runs over 100', designer will evaluate the need for galvanized rigid steel elbows to prevent damage during cable installation.

3. All duct will be installed in such a manner to prevent accumulation of water.

4. A red warning tape that is a minimum of 6" wide will be installed 18" above all duct banks.

5. Upon completion of installation of the duct and prior to pulling any cable in the duct, a mandrel ½" smaller than the nominal size of duct will be pulled through the duct.

6. Duct bank penetrations into manholes will continue completely through the wall of the manhole and will use one larger hole rather than several small holes. If above method is not practical, the concrete may stop outside the manhole but must be pinned to the manhole with steel pins to prevent differential settlement.

7. All unused duct will have a nylon or polypropylene pull string installed for future use. The pull string will be Greenlee or equal with a minimum of 240 lbs. tensile strength, and will be rot and mildew resistant. Wire will not be used.

8. Duct bank penetrations of foundation wall will comply with the following:

   a. Concrete encased duct banks will terminate at the exterior surface of the foundation wall. The conduit will make individual penetrations of the foundation wall.

   b. All duct banks will be attached to the foundation wall in one of two manners. In new construction, the reinforcing steel of the foundation wall may be extended into the concrete encasement of the duct bank at the time of placement. Alternately, reinforcing steel may be drilled into the foundation wall and extended into the duct bank concrete. The steel

that is inserted into the foundation wall will be attached through the use of epoxy capsules, similar to those supplied by Hilti.

c. All duct bank conduit within 8' of the foundation wall penetration will be rigid steel conduit. The conduit will be installed with a grade away from the building.

d. The conduit will penetrate the foundation wall in the following manner:
(1) For new construction, the foundation wall will have a steel sleeve installed that is 2" larger in diameter than the conduit to be installed. For existing construction, the hole will be core drilled. In multiple duct situations, sufficient space will remain between the penetrations to maintain the structural integrity of the foundation wall.
(2) A rubber seal, equal to Link-Seal, will be installed in the space between the conduit and the sleeve or drilled hole, near the interior surface of the foundation wall. The same space will have waterproofing installed on the exterior side of the rubber seal.

9. Concrete

a. Concrete will cover the duct a minimum of 3" in all directions, and a maximum of 6".

b. UMC & UMR Only: concrete will be 4,000 psi and will have the color additive "Colorcron - Tile Red" as manufactured by Masterbuilders, Solomon Grind Chemical Services #140 Red, or approved equal. The color additive will have a minimum concentration of 9 lbs. per bag of cement and will be mixed throughout all of the duct bank concrete.

c. Maximum aggregate size will be 3/4".

d. Concrete will be placed with the aid of a mechanical vibrator.

e. If trench erosion occurs, use of forms may be required to prevent overly large masses of concrete.

10. Minimum reinforcing of the concrete will be as follows:

a. Minimum size is #4.

b. Reinforcing will be installed longitudinally, at each corner of the duct (in

cross section) and along the top, bottom, and sides at a maximum of 6" on center. All reinforcing steel will have a minimum concrete cover of 1½".

c. Reinforcing will be installed latitudinal, as needed to hold the above in place during placement of the concrete.

B. Direct Burial Systems

1. All directly buried cable will have a minimum of 45" of earth cover with a minimum of 3" of sand placed both above and below the cable.

2. Two warning tapes, that are a minimum of 6" wide, will be installed 18" and 36" above all directly buried cable.

3. Penetrations into manholes will be run in Schedule 40 PVC conduit from the interior of the manhole to a point not less than 8' outside the manhole. A bell end will be installed on each end of the conduit. The conduit will be graded to drain any moisture away from the manhole.

4. Entrance into transformer pads will be run in Schedule 40 PVC conduit. The cable will maintain the minimum 48" of depth, then turn up directly below the transformer pad. The conduit will extend from the surface at the transformer pad to a point not less than 8' outside of the perimeter of the transformer pad. A bell end will be installed on each end of the conduit.

C. Medium Voltage (601 volts - 69,000 volts)

1. General

a. Cable exposed in manholes or trenches in substations will be arc proofed through the application of contractor furnished tape and binding. Arc proofing tape will be Irvington #7700 as manufactured by Minnesota Mining & Manufacturing Co., or approved equal, applied in a half lap spiral wind with a tape width suitable for the conductor size as recommended by the manufacturer. The arc proofing tape will be firmly held in place by a reverse spiral wound fiberglass tape equivalent to Scotch Brand #27.

2. Equipment

a. Transformers

(1) The basic transformer and switching will be as follows:

(a) Pad mounted, outdoor transformers with deadfront load break type elbows. Transformer protection will be "bayonet" or current limiting fuses as indicated by fault current. Radial units will be used. Transformers will have taps. Pad mounted outdoor fused air type 600 or 200 ampere switches will feed each radial transformer. The switches will be of the type which allow for loop feed.

(b) Transformers and switches will be separate units. All equipment for new or replacement installations will be rated for 15kv operation.

(c) All primary cable will be copper with cross-linked ethylene propylene rubber insulation rated 133% and Okonite Okoguard.

b. Designer will evaluate anticipated building harmonics to determine the K rating for each transformer installation. The K factor will be determined as follows:

Transformer K-Factor (Harmonic rating): transformers will be designed to operate at full KVA rating while carrying harmonic current contents as defined by the indicated K-Factor. Harmonic current content will be defined as odd harmonics (3^{rd} thru 49^{th} order). K-Factor will be defined as follows:

$$K = \frac{\sum_i (h_i)^2 * (fh_i)^2}{\sum_i (fh_i)^2}$$

where h_i = harmonic frequency, given as an integral multiple of the fundamental frequency.
and fh_i = Harmonic distortion, for the i^{th} harmonic, as percent of the unit fundamental frequency.

Transformer nameplates will be clearly marked with the transformer K-Factor rating.

(1) Fusing of transformers will coordinate with the owner's first upstream device.

(2) In all transformer installations, especially retrofit or replacement, the secondary system fault current will be analyzed.

(3) Transformer nameplates will contain information listed on the transformer nameplate data sheet located in the appendix.

c. Switch gear

(1) UMC Only: all pad-mounted switch gear will be type PMU or System 2, as manufactured by S&C.

(2) All switch gear and switch gear components must be rated for 25 KA(symm) available fault current and be tested to 25 KA(symm) by an independent testing agency.

(3) Pad-mounted or outdoor enclosure mounted switches will have hinged doors suitable for padlocking. Oil switches will have an oil sampling device provided with the oil drain valve. Oil or air switches will have the option of key interlocks as required for operating protection.

(a) UMC Only: cable terminations will be for a dead front device. Switch blades and fuses will be designed for visual inspection and maintenance accessibility. Switches will be suitable for 600 and 200 ampere feed. Configuration will be two loop switches and with one or two fused taps as indicated. Fuse holders will be suitable for a wide range of fuses including current limiting. Air switches will be S/C PMU-6 or PMU-9 or acceptable equal.

(b) Due to high fault currents on the medium voltage system, each switch application will require a study of the available fault current at the given location.

d. UMC Only: circuit breakers will be GE double high vacuum, rated to 1,000 MVA, and designed to be electrically and mechanically interchangeable with the Owner's existing GE vacuum circuit breakers.

d. The primary meter function is to reduce primary voltages and currents to a usable value for meters having a common secondary rating. Potential transformers are for measurement of a primary winding connected parallel with a circuit voltage. Current transformers are for measurement of a primary winding connected in series with a circuit carrying current.

(1) UMC Only: ratio for potential transformers is 20:1 for 2400 volt systems and 70:1 for 13,800 volt systems. Ratio for the

current transformer will be determined by the consultant.

(2) Metering equipment will be enclosed in a metal enclosure with doors suitable for padlock.

f. Fault indicators

(1) The electrical system will be equipped with fault indicators so visual inspection can be made to quickly determine what portions of the system had a fault current flowing through them when the system was opened by a circuit breaker or other type of fault current clearing device.

(2) The cable fault indicator will show a "fault" indication on all units up through the last indicator just ahead of the fault point on the cable.

(3) Fault indicators will be the automatic reset type designed for single phase application.

3. Execution

a. All cable installations where the calculated pulling tension exceeds 67% of the manufacturer's recommended maximum tension will be installed using tension measuring equipment. The Owner's representative must be present to observe these installations. These cable runs will be clearly marked on the plans.

b. All cable pulled through wet or damp conduit will be sealed on the end to prevent any moisture from entering the insulation.

4. Testing

a. Medium Voltage Cable - Direct-current High Voltage Test (D.C. HiPot): after installation and prior to being placed in service, all medium voltage cables will be tested by use of a D.C. HiPot test. Test voltages and procedures will be in accordance with ICEA standard S-68-516/NEMA standard WC-8 (latest edition). UMC Only: cable test data will be recorded on the medium voltage cable test data form included in the appendix of this section on page .

b. Transformers: the following test will be performed on each transformer prior to the unit being placed in service.

(1) Insulation resistance tests (5000 volt MEGGER) will be performed on high voltage and low voltage windings prior to placing the transformer in service. This test must be approved by the transformer manufacturer prior to testing.

(2) Transformer turns ratio testing will be done on all transformers prior to energizing.

(3) Each transformer will be energized from the low voltage bushings, and voltages measured (phase to phase) across the high voltage bushings. All primary and secondary voltages will be recorded and forwarded to the Owner.

5. All testing will be witnessed by the Owner's representative.

4.16.2 SECONDARY CIRCUITS

A General Requirements

1. Color code secondary service, feeder, and branch circuit conductors with factory applied color as follows:

208/120 Volts	Phase	480/277 Volts
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	White or Gray
Green	Ground	Green

B. Service Entrance

1. At the points where conduit penetrates concrete that is in contact with soil, that conduit will be Schedule 80 PVC conduit bedded in sand. If the PVC is a bend of greater than 45 degrees, the bend will be completely encased in concrete.

C. Feeders

1. All feeders will have a separate copper grounding conductor installed. In no case will the conduit or raceway be used as the grounding conductor.

2. All conduit sizes and conductor numbers and sizes will be shown on the drawings.

3. All panelboards will have separate grounding and neutral busses. All grounding and neutral wiring will be terminated on the proper buss.

4. No snap-in breakers will be allowed. Bolt-in type breakers will be used. Square D I-Line and GE Spectra Series are acceptable.

D. Branch Circuits

1. All wiring systems will be installed using conduit. Flexible wiring systems will not be used.

2. A separate grounding conductor will be installed. Use of the conduit or raceway is not an acceptable grounding method.

3. All general purpose power circuits will be a minimum of 20 amps.

4. No piggyback breakers will be allowed.

5. General purpose power circuits in office areas will not have shared neutrals.

6. Conduit will be supported from the building structure. Attachment to other pipes, conduits, ductwork, etc. will not be allowed.

7. Non-metallic conduit or boxes will not be used except in wet locations. In cases where it is used, conduit 2" and smaller will be a minimum of Schedule 80.

8. Conductors carrying more than 150v to ground will not be installed in conduits with conductors carrying less than 150v to ground.

E. Conduit

1. Schedule 80 PVC conduit will be utilized anywhere conduit emerges from concrete or where conduit may receive physical abuse.

2. EMT will not be used outdoors, in wet locations, in floor crawl spaces, or below 5' AFF.

3. For Branch Circuits, the minimum conduit size will be 3/4" except for switch legs and control wiring which may be ½".

4. For Feeders, conduit is to be sized at least one size above the NEC requirement of wire being installed or anticipated to be installed, with minimum size to be 1".

5. PVC conduit will be used for underground electric circuits less than 600 volts that are:

   Under paved areas and areas scheduled to be paved.

   Next to permanent buildings, under formal planting beds and in extremely high traffic areas that would be difficult to excavate due to regular heavy use.

   All other applications will be direct bury.

   A red plastic tracer tape is to be buried 18" above the cable or conduit in all installations.

6. PVC conduit will be Schedule 40 minimum weight and to be designed for electric application with all connections solvent welded.

7. All metallic fittings will be compression type rated for ground connection.

4.16.3 Devices & Motors

A. Devices

1. All receptacles and switches will have a minimum rating of 20 amps and will be heavy duty specification grade. A standard of quality for switches is Leviton #1221 and for receptacles is Hubbell #5362-I or Leviton #5362A-1.

2. Preferred color for receptacles and switches is ivory. Other colors may be used to match existing devices or for special uses.

3. In areas requiring to have ground fault interrupting capability, it is preferred GFI receptacles be used rather than GFI breakers.

4. Designer will evaluate the need for steel, nylon or other special types of covers, depending on the usage of the area.

5. The preferred mounting heights, above finished floor, are 48" for switches, and 18" for receptacles.

B. Fuses

1. Renewable fuses will not be used.

2. As much as possible, equipment should be specified with fuse holders that will accept fuses dimensionally the same as Class H fuses.

3. Each project will supply one set of three spare fuses for each type and size fuse installed.

4. Designer will evaluate the need for a box for storage of spare fuses. If a box is installed, it will be a metal box, designed to store fuses, mounted in a highly visible location, and labeled appropriately.

C. Safety Switches

1. All safety switches will be heavy duty grade.

2. All safety switches will have a durable label permanently attached to the inside of the cover describing the fuse size, type, current limiting ability and devices controlled.

3. All safety switches intended for use on circuits where current limiting fuses are required will be specified with rejection clips designed to permit installation of Class R fuses only.

4. Covers on safety switches will be provided with a method of opening the cover without opening the switch.

5. All safety switches will have a grounding bar.

6. Safety switches in mechanical rooms will have NEMA 3R enclosures unless the environment or usage requires a more restrictive enclosure.

D. Adjustable Speed Drive (ASD)

1. Variable Frequency Drive (VFD)

a. UMC & UMR Only: Toshiba E3 Drive Series shall be the basis of design for all variable frequency drives.

b. UMC Only: Where motors are 40 HP and larger, VFD shall be 480 volts with step up transformers as required.

c. Drives shall include manual bypass of the VFD for the following:
   (1) 480 volt drives 125 HP and larger
   (2) 208 volt drives 60 HP and larger
   (3) Critical applications

d. Manufacturer shall provide harmonic analysis of the supplied VFD, total harmonics are not to exceed 3%.

e. Manufacturer shall provide eight hours of start-up and training for the VFD.

f. Drive Isolation Transformer (where required for changing voltage):
   (1) General: factory assembled and tested, air cooled dry type transformer, having characteristics and ratings as indicated. Units shall be designed for 60 Hz service. Transformer shall be a three-phase, Delta Wye, or Delta-Delta unit.
   (2) Grounding: the transformer shall operate with an ungrounded delta primary and a grounded wye secondary, or a corner grounded Delta secondary.
   (3) Core: Grain Oriented, non-aging silicon steel.
   (4) Coils: continuous windings with no splices except for taps.
   (5) Insulation system: UL recognized 220°C. Performance shall be obtained without exceeding 150°C temperature rise while operating in 30°C ambient (24 hour average).
   (6) Enclosure: constructed of heavy gauge steel with electrostatic applied finish. Enclosure shall be ventilated, drip-proof with lifting holes.
   (7) Sound levels shall not exceed 55 db.
   (8) Non-linear rating: harmonic rating shall be equal to or greater than the harmonic distortion produced by the supplied VFD, as determined by the harmonic analysis supplied by the VFD manufacturer.

E. Identification

1. Installation for permanent identification of electrical equipment and systems will be specified per the following standard:

Panels at 480 and 240 V, 3 phase: PP Panels at 208/120 V, 3 phase and 240/120 V, 1 phase: LP Room number will follow the above designations. Panels(s) in a single room will be labeled as above with the added suffix A,B, or C... starting with first panel. A panel in a corridor will be assigned the number of the room on the otherside of the wall from the panel.

Special cases will add a designated prefix to the PP and LP identification:

E - Emergency Power (cover will be painted yellow)
U - Uninterruptible Power Source
C - Conditioned Power
D - Direct Current
The format will be: __ - _ - __ - ___ -
11 2 33 444 5
1=Building I.D.
2=Prefix for special case (E, U, C, D)
3=PP or LP
4=Room Number (24, 106)
5=Panel (A, B, C...)

4.16.4 LIGHTING

A. UMC Only: the following exterior light fixtures and standards will be provided:

1. Exterior lighting

a. All exterior lighting levels will comply with the latest editions of the Illuminating Engineering Society (IES) Lighting Handbook and ASHRAE/IES 90.1.

b. All lamps will be high pressure sodium. Other types of lamps may be used only with the approval of the owner if color rendition is critical to the activity anticipated for the area (baseball or tennis games, etc.). Incandescent lamps will not be used.

c. The White Campus preferred fixture for walkway lighting is a 16 inch diameter Globe type with a clear acrylic globe and cylindrical prismatic refractor (type III to V distribution). Fixtures should have multi-tap ballasts for 120 volt, 208 volt, or 277 volt systems and be individually fused. Fixtures shall be Sterner GLOBE-Lite GS series, catalog # GS-

16-IF-1A-N-100-S-(voltage)-E-(modification) or approved equal. In areas with existing fixtures of a different type, the designer should design to meet the campus standard rather than existing, however, final decision will be made by the Project Manager. Poles shall be Amercon Centrecon, Series S, Red Natural Aggregate #715, Catalog #SEQ-4-715-T.

d. The Red Campus preferred fixture for walkway lighting is luminaire – Spring City/Western lighting style FXK35. The poles are Spring City/Western lighting Wayzata style WZ-8.6-SS45.

e. The preferred fixture for parking lots and/or areas where tall poles (18 feet or more above grade) are used is the Shoebox type. Fixtures shall have multi-tap ballasts for 120 volt, 208 volt, or 277 volt systems and be individually fused.

f. Wiring for exterior light fixtures will be installed in Schedule 40 PVC conduit, ¾-inch minimum.

g. Poles
   (1) For walkways, bike paths, etc. the preferred pole height above grade is between10 feet above finished grade for Red Campus and 12 feet above finished grade for White Campus for Globe fixtures and between 18 foot and 25 foot for Shoebox fixtures. Walkway lighting adjacent to sidewalks, the centerline of the pole shall be three feet from the sidewalk edge. The actual pole height should be chosen after consideration of the life cycle cost, the existing and proposed plant material, and aesthetics of various heights in this range. Pole height should not be chosen with an assumption that existing plants can be pruned.
   (2) For parking lots and other large areas, taller poles may be used. Pole height should be chosen as described above. Poles taller than 25' should be anodized aluminum.
   (3) Galvanized steel poles may be used in either situation above if the site considerations warrant. Use of steel poles requires the approval of the owner.
   (4) Concrete base for all poles will have an additional, empty conduit stubbed out below grade at the time of installation. Ends of the conduit are to be capped.

g. Photocells will be used as the primary control system. Time clocks will be provided when additional energy savings can be achieved by limiting the hours of use to less than the hours of darkness. It is preferred that each fixture be controlled by an individual photocell.

g. The following guidelines are the target values for the design of exterior lighting projects. The requirements of IES and/or ASHRAE listed above may supersede these guidelines.

(1) For the main circulation walkways, sidewalks, and bikeways, the lighting level should be designed to 5 lux, average maintained, with an average/minimum luminance ratio no greater than 4:1.
(2) For surface parking lots, the lighting level should be designed to 10 lux, average maintained, with an average/minimum luminance ratio no greater than 4:1.
(3) For covered parking areas, the lighting level should be designed to 54 lux, average maintained, with an average/minimum luminance ratio no greater than 4:1 for lighting at night. The levels for lighting in the daytime are significantly different. The designer should carefully review the IES handbook for these levels.

h. For major construction projects displacing exterior lighting, the design will include temporary lighting around the perimeter of the project during construction. The contractor should be encouraged to maintain lighting within the limits of the project to increase security and safety. Temporary lighting does not need to meet this standard for fixture type, lamp type, etc., but should supply appropriate lighting levels for the areas adjacent to the project site.

B. UMSL Only: The exterior light fixture to be provided is Thomas' Gardco Lighting 'G18' Series.

4.16.5 COMMUNICATIONS & ALARM SYSTEMS

A. Telephone and Data Systems

1. General guidelines

a. Definitions:

(1) Main Distribution Frame (MDF) - frame on which external distribution cables between the BPX and system nodes terminate, together with their associated protective devices (on the vertical side) and with internal cables to the buildings Intermediate Distribution Frames (IDF) (on horizontal side). Interconnection is made by running jumper wires between termination blocks in MDF.

(2) Intermediate Distribution Frame (IDF) - frame which provides flexibility in distributing line pairs between servicing node MDF and building service. Incoming building cables are terminated on the vertical side. Building distribution to floor risers and/or runners to Terminal Distribution Cabinets (TDC) are connected to the horizontal side. Interconnection is made by running jumper wires between termination blocks in IDF.

(3) Terminal Distribution Cabinets (TDC) - cabinets and/or closets which are used to house the building riser and/or runner cable terminations. In addition, cable pairs allocated to a subscriber's number for connection to a line unit or equipment in a room or office are terminated at this location.

b. Terminal boxes will be standard electrical boxes (2" x 4" x 2") mounted flush with the wall surface in new construction. In existing buildings, terminal boxes may be surface mounted where necessary. Surface mounted boxes will be single gang deep switch and receptacle boxes, 4 5/8" x 2 7/8" x 2 1/4"; Wiremold 5744S or approved equal.

c. Instrument and/or equipment terminal jack will be of the RJ-11 duplex type. Terminal jack will be capable of being connected to three (3) twisted pairs, screw type connections. Terminate first two pair on top jack lug and third pair on bottom jack lug.

d. IDF will be located in a closet that can be locked or some other suitable unoccupied space. Area should be free of debris and relatively dust-free.

e. IDF will be constructed of standard telephone industry termination framing units. IDF frame may be a stand alone system or mounted on a sheet of new 3/4" plywood. If mounted on plywood, the plywood will be finished on one side and on all edges. Finish will be two coats of gray enamel paint. Plywood will be mounted on a wall using screw anchor fasteners. A minimum of 3' clearance will be provided in front of the frame, between it and any other surface or equipment, for workmen access to IDF. IDF will be grounded in common with the facility electric service ground. The frame will house Type-66B3-50 cross connect terminal blocks.

f. TDC may be located in a lockable closet or lockable panel box located elsewhere in a convenient location within the building on the floor or wing it serves.

g. TDC will be constructed of standard telephone industry termination framing units. Frame will be surface mounted on a sheet of new 3/4" plywood, finished and anchored to a wall, similarly to that for the IDF, and enclosed in a suitable enclosure. Frame will house Type-66B3-50 cross connect terminal blocks. TDC frame will be mounted on a sheet of new 3/4" painted plywood. A minimum of 3' clearance will be provided in front of the cabinet, between it and any other surface equipment, for workmen access.

h. Cabling and/or wiring horizontal feeds between the IDF and the TDC will be installed in overhead cable racks located in equipment rooms or concealed above ceilings. Cable racks will be Newton, series 2092, or approved equal. Vertical feeds will be in conduit and may be attached to wall surfaces in normally unoccupied areas in accordance with REA standards. Where it is not possible to conceal the conduit, the cabling and/or wiring will be installed in surface mounted raceway; i.e., Wiremold 500 or 700 series. The minimum size conduit for any installation will be 3/4". Free standing runs will not be acceptable.

i. Cabling pair count from IDF's to TDC's will be 30% in excess of service wiring requirement. The minimum spare capability, however, to any TDC will be no less than six (6) twisted pair. Planned uses for spare wire pairs include point-to-point tie to campus police panel for fire communications; etc.

j. All telephone cable will be run continuous between the IDF and the

TDC and the terminal jack; no splicing will be allowed. Cables will be terminated in a standard electrical terminal box of the type specified.

k. Cabling pair count to terminal duplex jacks will be a minimum of four (4) twisted pair.

l. Cable will be:

- AT&T Category 5 UPT; 4 pair, 24 AWG, plenum rated. AT&T Part #2061004BBLR1000 (blue).

- AT&T Category 5 UPT; 4 pair, 24 AWG, non-plenum rated. AT&T Part #1061004CBLR1000 (blue).

- AT&T Category 5 SPT

m. Color coding for twisted pairs within each cable will comply with the standard telephone industry coding scheme. Attached is a table showing color coding for cables up to and including 25 twisted pair. Larger cables repeat this color code for each 25 pair or portion thereof.

n. In new buildings, contractor will make cable connections in the TDC from both the terminal jack and the IDF and at the mounted terminal jack. Cable from the TDC to the IDF will be of a minimum length equal to extending the cable to the top center of the IDF plus the sum of the vertical height of the IDF plus 3'. Once cable is installed, the contractor will use a loop meter to assure continuity and resistance levels are satisfactory as per REA standards. Each wire pair will be tagged and labeled at the IDF end to identify room number and terminal jack which it serves.

o. For existing buildings, the contractor will make the cable connection at the mounted terminal jack. Cable from the terminal jack to the TDC will be of a minimum length equal to extending the cable to the top center of the TDC plus the sum of the vertical height of the TDC plus 3'. Once cable is installed, the contractor will use a loop meter to assure continuity and resistance levels are satisfactory as per REA standards. Each wire pair will be tagged and labeled at the TDC end to identify room number and terminal jack which it serves.

2. Pathways (interior)

   a. Sections of conduit will be no longer than 100' and must not have more than 2 bends between pull points or pull boxes with individual bends not to exceed 90 . Inside bending radius must be at least 6 times the inside conduit diameter for conduit 2" or less and at least 10 times the conduit diameter for conduit greater than 2". Pull boxes should be placed directly after a bend or sized accordingly if the pull box is located at the bend.

   b. Conduit will be sized to avoid exceeding the following cable fill maximums:

      3" conduit - 50 cables maximum
      2" conduit - 22 cables maximum
      1" conduit - 7 cables maximum
      ¾" conduit - 4 cables maximum

   c. Terminal boxes will be standard electrical boxes; 2" x 4" x 2" mounted flush with the wall surface in new construction. In existing buildings, terminal boxes may be surface mounted where necessary. Surface mounted boxes will be single gang deep switch and receptacle boxes, 4 5/8" x 2 7/8" x 2 ¼"; Wiremold 5744S or approved equal.

3. The specifications should require the contractor's submittal to the Owner of a copy of loop meter readings for each cable prior to requesting final payment.

B. Fire Alarm Systems

1. Acceptable manufacturer for fire alarms systems are Notifier, FCI, and Cerberus Division.

2. Vendor for fire alarms systems must show the ability to respond to requests for service within 24 hours and the ability to supply replacement parts for the system within 48 hours.

3. All fire alarm panels will be equipped with a "walk test" feature. This allows each activating device to be tested without the need to reset the panel after each device is activated.

4. All fire alarm panels will be equipped with a "building evacuate" switch.

5. Each circuit, initiating and notification, will have a disconnect switch in the Fire Alarm Control Panel (FACP) to disable the circuit during maintenance.

6. Power expander units external to the FACP are prohibited unless approved by the Project Manager.

7. If door hold-opens are used, they will be wall-mounted, magnetic type with proper mounting blocking in the wall. Combination door closer/hold-opens will not be used.

8. All pull stations will be key operated, keyed the same as the building fire alarm panel.

9. Ionization type smoke detectors will not be allowed unless directed by the Project Manager.

10. All detectors or other activating devices will be installed in locations that are readily accessible for maintenance. Any initiating device installed above a suspended ceiling (i.e. duct smoke detectors) shall have an indicator showing below the ceiling the location of the device. Beam detectors will be used in atriums or other high ceiling areas.

11. When fire alarm systems are installed in buildings with elevators, provisions will be included for main or alternate floor recall. Connection between the fire alarm system and the elevator shall be as directed by the Project Manager.

12. Wiring shall be U.L. listed as fire alarm protection signaling circuit cable per NEC. Wire for analog loops will be a minimum of #18 AWG, twisted pair, shielded type FPL, FPLP, FPLR. Wire for notification circuits will be a minimum #14 AWG, type KF-2 or KFF-2. Alarm speaker wire will be a minimum #14 AWG, shielded type CM. Cable type may vary if recommended by the system manufacturer for compatibility with system warranty or design.

13. All fire alarm system wiring will be concealed in a dedicated raceway.

14. Ground fire alarm equipment, conductors, and cable shields per NFPA and manufacturer.

15. Fire alarm horns shall be 85 dBA output at ten (10) feet. Horns will be

Wheelock NH or AH series or equal.

16. Fire alarm strobe flash rate to be one flash per second with zero inrush current. Strobes will be Wheelock RSS series or equal.

17. Synchronized strobes are required where more than one strobe is visible from any location, including corridors. Where synchronized strobes are used, use appropriate control module based on manufacturer=s recommendations, such as Wheelock SM, DSM or equal.

18. Alarm speakers will be Wheelock series ET or equal.

19. Before partial occupancy, on all fire alarm installations or modification, manufacturer shall provide a written satisfactory completion of the required test outlined in NFPA 72.