

**Roofing:**

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1. Materials used for moisture protection will comply with specifications contained in the appropriate American Society for Testing and Material standards (ASTM).
2. General roof specification information:
  - The use of any asbestos-containing materials is prohibited.
  - Organic felts shall not be used. Modified Bitumen can be used.
  - Surface nailing should not be allowed.
  - 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 daylight, or overflow parapet scuppers. (Re-roof construction drainage should be reviewed for overflow with the PM). Consultant is to evaluate roof drainage system volume as per current (IPC) International Plumbing Code requirements.
  - Consultant is to evaluate roof drain system volume as per 100 year rainfall as defined by code.
  - It is preferred that all new construction slope should be built into structure.
  - Calculate “minimum” R-Value on new insulation systems and “average” R-Value on reroof insulation systems.
  - *The consultant will plan safe, OSHA compliant; tie-offs, guardrails, and reasonable access for servicing and maintenance of equipment. Minimize rooftop equipment and roof penetrations by consolidating equipment in mechanical penthouses.*
3. *Consultant should also consider:*
  - *Initial (first) cost of the roof system and additional building costs required for recommended roof system.*
  - *Maintenance costs and requirements. Consultant is to provide roof lifecycle cost analysis.*
  - *Energy costs associated with recommended roof system.*
  - *Building height/roof slope/wind resistance requirements.*

- *Present and future use of building, including specific uses in the building that could affect the roof system.*
- *Local environmental issues/contaminants and pollutants.*
- *Life expectancy of building.*
- *Structural properties of roof superstructure.*
- *Type of roof deck.*
- *Slope/drainage.*
- *Vapor retarder requirements.*
- *Roof traffic/access and penetrations.*
- *Code/Insurance requirements and restrictions.*
- *Aesthetics.*
- *HVAC internal pressures.*
- *Application issues, such as staging, access, building use and occupancy, etc.*
- *Use crickets, saddles, and edge strips to direct water flow away from parapets and penetrations. Back slope is to be confirmed during detailing.*
- *Provide roof walkways to and around rooftop equipment and other areas as directed by the owner.*
- *At the design development phase, a review should be undertaken by the consultant to include vapor retarder requirements deck type, expansion joint locations and details, salvage-ability of existing roof insulation, drainage, roof access, roof contaminants, fire rating, and wind uplift factors, and all other applicable parameters.*
- *Existing roof decks will be checked by a registered structural engineer if roof loads are in question.*
- *For re-roof projects, as determined by the PM, an evaluation will be done by the consultant and the owner to determine if a roof survey by nuclear meter or other means may be performed. Core samples will be taken and results recorded and evaluated.*
- *Roof access will be evaluated, and roof access hatches, ladders, fall protection, and other components will be installed as required by the owner.*
- *Minimize roof penetrations. If structural penetrations are unavoidable, use round or square structural steel shapes to facilitate flashing. Equipment supports for rooftop mounted equipment shall be a minimum 14" height. Use prefabricated equipment supports where possible. Equipment support frames or stands shall provide following working clearances:*

| <i>Width of Equipment</i> | <i>Height of Legs</i> |
|---------------------------|-----------------------|
| <i>Up to 25"</i>          | <i>14"</i>            |
| <i>25-37"</i>             | <i>18"</i>            |
| <i>37-49"</i>             | <i>24"</i>            |
| <i>49-61"</i>             | <i>30"</i>            |
| <i>Over 61"</i>           | <i>48"</i>            |

4. Roof system approval process:  
All roof systems types must be pre-approved by the University. This is an internal process, consisting of the following:
- Roof manufacturer submits the following information to the UM System Facilities Planning and Development:
    - Roof system technical data
    - List of approved regional installers
    - 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
  - The UM Architectural Standards Committee evaluates all aspects of the proposed system. The Committee members are appointed by the Facilities Directors of each campus to help maintain all Design Guidelines with the assistance of UM System Facilities Planning and Development.
  - If necessary, the manufacturer meets with committee to review submitted materials and respond to questions.
  - UM Architectural Standards Committee approves or rejects the proposed roof system. In addition, updated listings are included in the most current version of the Consultant Procedures and Design Guidelines

## **ROOFING**

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1. Design Standards include:
- Wind requirements for roof system as per current (IBC) International Building Code, unless otherwise noted by PM.
  - Underwriters Laboratory (UL). UL labels are required for each membrane, with top side fire rating meeting ASTM E108 Class A.

- National Roofing Contractors Association (NRCA), Roofing and Waterproofing Manuals and Construction Details.
    - Steep-Slope Roofing Systems
    - Metal Panel and SPF Roof Systems
    - Membrane Roof Systems
    - Architectural Metal Flashing, Condensation Control, and Reroofing
  - Sheet Metal and Air Conditioning Contractor's Association International (SMACNA), Architectural Sheet Metal Manual.
  - American Society for Testing and Materials (ASTM) applicable standards.
2. Consultants will base roof specifications on the University of Missouri's Design Guidelines. All roof systems must be prequalified (see list of systems below):
- Built-Up Roofing Systems/Asphalt (BUR)
  - Modified Bitumen (MB) - SBS (Styrene Butadiene Styrene)  
Polymer-modified bitumen membranes
  - Modified Bitumen (MB) - APP (Atactic Polypropylene)  
Polymer-modified bitumen membranes
  - EPDM (ethylene propylene diene monomer)
  - PVC (polyvinyl chloride) (ASTM D4434)
  - TPO (thermoplastic olefin) (ASTM D6878)
  - Metal Roofing Systems and Architectural Standing Seam
  - Slate Roofs/ Clay Tile (concrete, and simulated slate)
  - Asphalt Shingles
3. **Recommended Roof Membrane and Insulation Assemblies**
- **Built-up asphalt (BUR)**  
Membrane: four plies of Type IV glass felts in Type I or Type III asphalt moppings. 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 (average R-value for re-roof & minimum R-value for new roofs) rigid polyisocyanurate. R-value shall not be less than required by current ASHRAE 90.1 Standards. 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. Mechanically fastened except over concrete deck or vapor retarder.

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

Substrate board type should be based on the roof system fire rating as defined by applicable code requirements.

Cover Board: ¼” thick minimum high density roof board.

Base Flashings: mineral surfaced modified bitumen sheets.

Cap sheet: Granulated.

- **(SBS) or (APP) Type Modified Bitumen Sheet Systems**

**Membrane:**

To consist of a base sheet, inter-ply sheet and cap sheet of SBS type sheets bonded with hot asphalt or approved adhesives. Hot air welded seams are preferred. Polyester or fiberglass reinforcement is allowable per manufacturer's roof systems. Standard test methods for sampling and testing SBS Modified Bitumen material shall comply with ASTM D-6162, D-6163, D-6164; for APP (MB) comply with ASTM D6222, and D6223.

Insulation: R-20 (average R-value for re-roof & minimum R-value for new roofs) rigid polyisocyanurate. R-value shall not be less than required by current ASHRAE 90.1 Standards. 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. Mechanically fastened except over concrete deck or vapor retarder.

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

Substrate board type should be based on the roof system fire rating as defined by applicable code requirements.

Cover Board: ¼” thick minimum high density roof board.

(S&T) – Rolla Cover Board: 1/2” thick minimum high density roof board.

Base Flashings: SBS or APP material furnished and installed per roof manufacturer’s recommendations. Polyester reinforcement required.

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.

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

- **EPDM -Fully adhered**

Membrane: minimum 60 mil thick EPDM sheet. Use seam tape as supplied and approved by manufacturer.

Insulation: R-20 (average R-value for re-roof & minimum R-value for new roofs) rigid polyisocyanurate. R-value shall not be less than required by current ASHRAE 90.1 Standards. 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. Mechanically fastened except over concrete deck or vapor retarder.

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

Substrate board type should be based on the roof system fire rating as defined by applicable code requirements.

Cover Board: 1/4” thick minimum high density roof board.

(S&T) – Rolla Cover Board: 1/2” thick minimum high density roof board.

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.

Termination bars to be covered with a reglet and counter-flashing.

- **PVC (polyvinyl chloride) (reinforced) (ASTM D4434)-Fully Adhered Membrane:** minimum 45 mil thick fabric reinforced sheet with heat weld seaming.

Insulation: R-20 (average R-value for re-roof & minimum R-value for new roofs) rigid polyisocyanurate. R-value shall not be less than required by current ASHRAE 90.1 Standards. 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. Mechanically fastened except over concrete deck or vapor retarder.

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

Substrate board type should be based on the roof system fire rating as defined by applicable code requirements.

Cover Board: ¼” thick minimum high density roof board.

(S&T) – Rolla Cover Board: 1/2” thick minimum high density roof board.

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.

- **TPO (thermoplastic olefin) (ASTM D6878) -Fully Adhered**  
Membrane: minimum 40 mil thick fabric reinforced sheet with heat weld seaming.

(S&T) – Rolla, minimum 80 mil thick fabric reinforced sheet with heat weld seaming, unless otherwise approved by PM.

Insulation: R-20 (average R-value for re-roof & minimum R-value for new roofs) rigid polyisocyanurate. R-value shall not be less than required by current ASHRAE 90.1 Standards. 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. Mechanically fastened except over concrete deck or vapor retarder.

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

Substrate board type should be based on the roof system fire rating as defined by applicable code requirements.

Cover Board: ¼” thick minimum high density roof board.

(S&T) – Rolla Cover Board: 1/2” thick minimum high density roof board.

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.

- **Metal Roofing-Structural Standing Seam (SSR)**  
Structural metal roofing shall meet uplift rating as required by current IBC. Sheets shall have a steel or aluminum core (minimum 22 gauge) and corrosion protection provided by a "Kynar" coated finish. Slope should be no less than 1" per foot. No lateral splice joints, or field seaming. Factory formed integral standing seam structural panels are preferred. Concealed



fasteners are preferred. Ice guards are required on all eaves, exceptions can be proposed by consultant, PM approval is required.

Metal roofing system is to include a proper underlayment/vapor barrier, and insulation; R-value shall not be less than required by current (IECC) International Energy Conservation Code requirements.

- **Slate**

Slate material shall be Type S1 slate as specified by ASTM C406 (90-110 year performance life). Minimum 5/16" Thickness. Natural slate may be installed in slopes as shallow as 4" 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 all eaves, exceptions can be proposed by consultant, PM approval is required.

- **Asphalt Shingles**

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

#### **4. Roof Deck**

A registered structural engineer shall design roof decks. The design consultant shall determine code specified 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. 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.

All wood curbs, blocking, sub-fascia, etc. should be fire retardant preservative treated material.

**5. Vapor Retarders**

Design consultant shall investigate and recommend vapor retarder requirements for both new and reroof assemblies. The design consultant is required to provide a dew-point analysis study and calculations for PM review.

**6. Warranties & Certification**

Roof manufacturer and roof installer will provide the following items:

- The University of Missouri Roofing System Manufacturers Certification.
- 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:
  - Roofing membrane (built-up felts or single-plys), slate, shingles, or metal roofs
  - Flashing and counterflashing
  - Insulation
  - Vapor barrier
  - Fasteners and adhesives
  - Sealants and caulking
  - Ballast and ballast stops
  - Walkway mats & pavers
  - Roof hatches, and equipment curbs
  - Gutters, downspouts, and fascia panels
  - Roofing accessories, as required making a complete roofing system
  - 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.

- 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 twenty (20) 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 the code required design wind loads.

- 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.
- 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 breach 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.
- The following are excluded from this warranty:
  - Roof maintenance.
  - Damage to any part of the building (other than the roofing system) or to its contents.
  - Damage resulting from any one of the following:
    - Cracking, warping, deflection or movement of building foundation.
    - Natural disasters such as earthquake, hail, or wind exceeding the code required design wind loads.
    - Accidents, vandalism, or other uncontrollable events.

- Chemical attacks on the membrane from sources not present at time of roofing system installation.
- Excessive movement or deterioration of metal components adjacent to the roof or engaged therein.

## **7. Roof Installation**

- Roofing contractor must have the following qualifications:
  - A minimum of five years' experience, and manufacturer's certification to install the specified roof system.
  - Roof manufacturer certification as an installer for specified roofing systems.
  - 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.

## **8. Roofing Accessories**

- Parapet wall coping will be constructed with metal selected from one of the following materials:
  - Sheet metal, 22 or 24 gage, galvanized, factory finished with Kynar 500
  - Copper, ASTM B370, 16-20 oz.
  - Aluminum, .032" or .040", factory finished with Kynar 500
  - Stainless steel, .018 soft buff
- 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.
- Sheet metal roof accessories will be constructed with metal selected from one of the following materials:
  - Sheet metal, 20 gauge, galvanized, factory finished with Kynar 500
  - Copper, ASTM B370, 16-20 oz.
  - Aluminum, ASTM B209, alloy 3003, AA-C22A41 clear anodized finish, minimum 20 gauge
  - Solder, 50/50 ASTM B32
- Consultant should evaluate the need for walk-off mats to protect roof system in areas requiring foot traffic to access equipment, etc.
- Consultant should evaluate the need for ice guards at all eaves.

END OF SECTION