Division 7 – Thermal & Moisture Protection

General

Division 7 Contractors shall have a minimum of 5 years of experience in the installation of air, thermal, water and moisture protection systems of the type of work specified for this project. Division 7 Contractors and installers shall be certified and trained by the manufacturer for installing all Division 7 systems.

Thermal and Moisture Protection Contractors are to engage full-time competent site representatives to supervise the installation of the Division 7 materials, and to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components.

The Project Design Team shall ensure that all Division 7 systems are compatible.

Exterior Insulation and Finish Systems (EIFS) are not allowed without permission from the TTUS Project Manager.

Texas Tech FP&C will participate in the pre-installation meetings for new construction and shall be given a minimum of two (2) weeks advance notice of intent to start installation of any Division 7 thermal and moisture protection component. Texas Tech representatives must be permitted to perform a pre-installation inspection of roofing materials and equipment, to be present throughout roofing installation to observe installation techniques for compliance with specifications and to participate in final inspection. A pre-roofing conference should be included in specifications.

The roofing contractor shall install all roof flashings required to make a complete waterproof installation. Roofing system shall be watertight without depending on any metal flashing or coping.

Design Professionals will use “RoofNav”, FM Approvals' Web-based tool for roofing professionals, as a step-by-step guidance on how to identify, configure and install various roofing assemblies and components that comply with FM Approvals roofing standards. This is a complimentary design tool from FM Global and can be found at **fmglobal.com**. RoofNav provides all the roofing-related information from the *Approval Guide* and related installation recommendations from relevant FM Global Property Loss Prevention Data Sheets. Roofing systems not listed, must be approved by FP&C Design Team and FM Global.

The roofing Contractor shall submit the FM Global “Checklist for Roofing System” sheet with material submittals.

The design of all roof flashing components should be in accordance with the FM Global Data Sheet 1-49, “Perimeter Flashing” requirements.

Bituminous Waterproofing

Surfaces of exterior walls (if applicable) and walls below grade, which will receive an applied finish, shall be primed and coated with bituminous waterproofing prior to installation of furring. Proceed with application only after substrate construction and penetrating work have been completed and unsatisfactory conditions have been corrected. Test for surface moisture according to ASTM D 4263.

For each type of product indicated, include recommendations for method of application, primer, number of coats, coverage or thickness, and protection.

Proceed with installation only when existing and forecasted weather conditions permit waterproofing to be performed according to manufacturers' written instructions.

Comply with manufacturers' written recommendations unless more stringent requirements are required by Project conditions to ensure satisfactory performance of waterproofing. Apply additional coats if recommended by manufacturer or if required to achieve the coverages indicated. Allow each coat of to cure 24 hours before applying subsequent coats. Allow 48 hours drying time prior to backfilling.

Apply waterproofing to provide continuous plane of protection on exterior face of inner wythe of exterior masonry cavity walls. Extend waterproofing over outer face of structural members and concrete slabs that interrupt inner wythe, and lap waterproofing at least 1/2 inch onto shelf angles supporting veneer. Lap waterproofing at least 1/2 inch onto flashing, masonry reinforcement, veneer ties, and other items that penetrate inner wythe.

Submit manufacturer's standard warranty form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within five (5) years from date of substantial completion.

Submit installers standard warranty form in which installer agrees to a warranty period of (2) years from date of substantial completion.

Self-Adhering Sheet Waterproofing

Installer shall be a firm that is approved or approved by the waterproofing manufacturer for installation of waterproofing required for this Project.

Store rolls according to manufacturer's written instructions.

Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate. Do not apply waterproofing in snow, rain, dust, fog, or mist.

Submit manufacturer's standard warranty form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within five (5) years from date of substantial completion.

Submit installers standard warranty form in which installer agrees to a warranty period of (2) years from date of substantial completion. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

Rubberized asphalt sheet waterproofing shall be a composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, 8-mil cross-laminated polyethylene film to produce an overall thickness of not less than 56-60 mils. Physical properties to meet or exceed:

1. Tensile Strength: 800 psi minimum; ASTM D 412, Die C, modified.
2. Ultimate Elongation: Per ASTM D 412, Die C, modified.
3. Low-Temperature Flexibility: Unaffected at minus 45 deg F; ASTM D 1970.
4. Puncture Resistance: 80 lbf minimum; ASTM E 154.
5. Water Absorption: 0.1percent maximum; ASTM D 570.
6. Vapor Permeance: 0.05 perms maximum; ASTM E 96, Method B.

Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water. Owner reserves the right to engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

Install rubberized asphalt sheets according to waterproofing manufacturer's written instructions and according to recommendations in ASTM D 6135.

Cold Fluid Applied Waterproofing

Installer shall be a firm that is approved or licensed by waterproofing manufacturer for installation of waterproofing required for this Project.

Obtain waterproofing materials, protection course and molded-sheet drainage panels from single source from single manufacturer.

Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing in snow, rain, dust, fog or mist, or when such weather conditions are imminent during application and curing period.

Before beginning installation, install waterproofing to 100 sq. ft. of wall to demonstrate surface preparation, crack and joint treatment, corner treatment, thickness, texture, and execution quality.

Submit manufacturer's standard warranty form in which manufacturer agrees to replace waterproofing material that does not comply with requirements or that fails to remain watertight within 10 years from date of substantial completion.

Submit installer's standard warranty form in which installer agrees to a warranty period of 2 years from date of substantial completion. Warranty includes removing and reinstalling protection board, drainage panels, insulation, and other overtopping construction.

Clean and prepare substrate according to manufacturer's written recommendations. Provide clean, dust-free, and dry substrate for waterproofing application.

Prepare vertical and horizontal surfaces at terminations and penetrations through waterproofing and at expansion joints, drains, and sleeves according to ASTM C 898, ASTM C 1471, and manufacturer's written instructions.

Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 898, ASTM C 1471, and waterproofing manufacturer's written instructions. Remove dust and dirt from joints and cracks, complying with ASTM D 4258, before coating surfaces.

Where applicable, test horizontal surfaces per, according to recommendations in ASTM D 5957.

Hot Fluid Applied Rubberized Asphalt Waterproofing

Installer shall be a firm that is approved or licensed by manufacturer for installation of the membrane system as required for this Project.

Submit for each type of product indicated. Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.

Obtain waterproofing materials, sheet flashings, protection course, and molded-sheet drainage panels from single source from single manufacturer.

Install waterproofing to 100 sq. ft. of deck to demonstrate surface preparation, crack and joint treatment, corner treatment, thickness, texture, and execution quality. Install pavers and paver supports to demonstrate aesthetic affects and set quality standards for materials and execution.

Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate. Do not apply waterproofing in snow, rain, dust, fog, or mist.

Submit manufacturer's standard warranty form in which manufacturer agrees to replace membrane system material that does not comply with requirements or that fails to remain watertight within 10 years from date of substantial completion.

Submit installer's standard warranty form in which installer agrees to a warranty period of 2 years from date of substantial completion. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pedestal-mounted pavers on decks.

Hot fluid-applied rubberized-asphalt waterproofing membrane to be single component, 100 percent solids, hot fluid-applied, rubberized asphalt.

Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify that concrete has cured and aged for minimum time period recommended by waterproofing manufacturer. Verify that substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.

Clean and prepare substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for waterproofing application.

Prepare and treat substrates to receive waterproofing membrane, including joints and cracks, deck drains, corners, and penetrations according to manufacturer's written instructions.

Install elastomeric flashing sheets at terminations of waterproofing membrane according to manufacturer's written instructions.

Apply primer, at manufacturer's recommended rate, over prepared substrate and allow drying.

Flood test each deck area for leaks, according to recommendations in ASTM D 5957, after completing waterproofing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water. Owner reserves the right to engage an independent testing agency to observe flood testing and examine underside of decks and terminations for evidence of leaks during flood testing.

Building Insulation

All products shall meet, at a minimum, the State Energy Conservation Office (SECO) Design Standards and be FM Global Approved.

Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

For glass-fiber blanket insulation, supply un-faced, meeting ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics. Insulation is to be manufactured with 100 percent acrylic binders and no formaldehyde.

For open-Cell Polyurethane Foam Insulation, spray-applied polyurethane foam using water as a blowing agent, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84. Foam insulation product and installation method to be FM Global approved.

Plastic construction materials (rigid, flexible or spray applied) should be avoided except where FM Approved. If Insulated Panels (sandwich panels) are utilized for any building structure, these panels should be FM Approved and listed in the FM Global Approval Guide.

Comply with insulation manufacturer's written instructions applicable to products and applications indicated.

For metal-framed wall cavities where cavity heights exceed 96 inches, support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.

Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using loose-fill Insulation compacted to approximately 40 percent of normal maximum volume equaling a density of approximately 2.5 lb/cu. ft.

Where glass-fiber blankets are indicated for sound attenuation above ceilings, install blanket insulation over entire ceiling area in thicknesses indicated. Extend insulation 48 inches up either side of partitions.

Fluid Applied Membrane Air Barriers

Specify materials and installation methods supplementing a one-component vapor permeable, liquid applied, elastic air, and water barrier, vapor retarder materials and assemblies.

Materials and installation to bridge and seal the following air leakage pathways and gaps will include, but not be limited to the following:

1. Connections of the walls to the roof air barrier.
2. Connections of the walls to the foundations.
3. Expansion joints.
4. Openings and penetrations of window frames, store front, curtain wall.
5. Barrier precast concrete and other envelope systems.
6. Door frames.
7. Piping, conduit, duct and similar penetrations.
8. Masonry ties, screws, bolts and similar penetrations.
9. All other air leakage pathways in the building envelope.

10. Sealing flashing to wall surface.

Provide an air barrier system constructed to perform as a continuous elastic air barrier, and as a liquid water drainage plane flashed to discharge to the exterior any incidental condensation or water penetration. Membrane shall accommodate movements of building materials by providing expansion and control joints as required, with accessory air seal materials at such locations, changes in substrate and perimeter conditions.

1. The air barrier shall have the following characteristics:
    a. It must be continuous, with all joints made air-tight.
    b. It shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on the envelope without damage or displacement, and shall transfer the load to the structure. It shall not displace adjacent materials under full load. The air barrier shall be joined in an airtight and flexible manner to the air barrier material of adjacent systems, allowing for the relative movement of systems due to thermal and moisture variations and creep. Connection shall be made between:
        1) Foundation and walls.
        2) Walls and windows or doors.
        3) Different wall systems.
        4) Wall and roof.
        5) Wall and roof over unconditioned space.
        6) Walls, floor and roof across construction, control and expansion joints.
        7) Walls, floors and roof to utility, pipe and duct penetrations.
        8) Flashing to wall surface.
2. All penetrations of the air barrier and paths of air infiltration/exfiltration shall be made air-tight.
3. Bond Strength to Concrete, FBC (FL Bldg. Code), TAS 114, Appendix H, Section 2, resulting in > 1,000 pounds.
4. Air Permeability: Per Design Professional's recommendation.
5. Shall meet ASTM E 2357, Full Scale Wall Testing of the Air Barrier System.
    a. System Air Leakage, Requirement – 0.04 CFM/ft² maximum.
    b. Penetration Check, Requirement – shall pass ASTM E237 requirements.
6. Water Vapor Permeance: 10-14 Perms per ASTM E96 Method B.
7. Elongation: ASTM D412: >75%

Submit in writing, a document stating that the applicator of the primary air barrier membrane specified in this section is recognized by the manufacturer as suitable for the execution of the Work.

When specified by the Design Professional or directed by Owner's Representative, before beginning installation of air barrier, build a mockup to verify selections made under sample submittals and to demonstrate quality standards.

Do not apply air barrier to a damp or wet substrate or during snow, rain, fog, or mist. Apply by spray or roller, a complete and continuous unbroken film at a temperature of 40F and rising with less than a 30% chance of rain in the next 24 hours.

Clay Roof Tiles

The clay roof tile work shall be performed by a single firm specializing in commercial roofing systems and having a minimum of five years' experience in installing clay roof tile of the type specified in this section. References will be made available upon request.

Clay roof tiles shall be installed and secured to withstand wind uplift pressures calculated as detailed in FM Data Sheet 1-28.

Prior to the start of installation, erect a 4'x8' sample panel in a location selected by the TTU Project Manager demonstrating the material, attachment methods, mortar application/color, and tile color blends. The sample panel shall be approved by the TTU Project Manager prior to procurement or proceeding with the installation.

The manufacturer's warranty period is seventy-five (75) years, from the date of Substantial Completion. The written warranty by the manufacturer will include agreeing to replace roofing tiles that fail in materials or workmanship. Failures include, but are not limited to, deformation or deterioration of roofing tiles beyond normal weathering or failing in winds less than 72 mph.

The Roofing Contractor shall furnish a minimum two (2) years unlimited applicator's warranty covering materials and workmanship for the clay tile roofing and flashing systems. The warranty shall cover leaks which result from either material or workmanship defects, shall not be subject to a deductible, and shall not be prorated. Warranty coverage shall include repairs to the roofing system to the extent necessary to return the roofing system to a watertight condition. The warranty period shall begin on the date of Substantial Completion.

Clay roofing tile shall be straight Barrel Mission style as manufactured by one of the following. "S" style tile may be considered based on the project location and design. Standard tile length will be 18" but other alternative lengths may be considered based on architectural aesthetics.

1. Ludowici-Celadon, Inc.
   New Lexington, Ohio
   a. The color range shall be as follows:
      Pan Tile - 100% Clay Red (unglazed)
      Cover Tile - 60% Clay Red (unglazed)
      25% 25MT3 (Brown glazed)
      15% Desert Sand (glazed)
      Available lengths are 14-1/4", 16", and 18 3/8".
      Ludowici "S" style shall be Spanish 18 3/8" with blend to match above.

2. Gladding McBean
   Lincoln, CA
   a. The color range shall be as follows:
      Pan Tile - 100% Blended Red
      Cover Tile - 60% Blended Red
      25% #8 Mix
      15% Monterey – No Flash
      Only available in 18" length.
      No "S" style tile is available at this time.

~~3. Maruhachi Ceramics of America, Inc. (MCA)~~
~~Corona, CA~~
~~a. The color range shall be as follow:~~
~~Pan Tile – 100% UA02 F40 8" straight barrel in Natural Red~~
~~Cover Tile – 60% UA02 F40 8" straight barrel in Natural Red~~
~~25% UA02 CF8 8" straight barrel Brown~~
~~15% UA02 2F4634D-SM 8" straight barrel Gold color~~
~~"S" tile style to be "Classic S" with blend to match above.~~

Obtain clay roofing tiles from a single source from a single manufacturer.

Appropriate special shapes in the same color blend by the same manufacturer shall be supplied at rakes, ridges and hips. Lengths to match existing shall be used for repairs or additions to existing buildings.

Clay roof tile underlayment shall be equivalent to TAMKO TW Metal and Tile Underlayment, fiberglass reinforced, self-adhering rubberized sheet membrane, 75 mil thickness, meeting the requirements of ASTM D-1970. Stripping ply for batten boards shall be equivalent to TAMKO TW Moisture Wrap, non-reinforced, 40 mil thickness.

Flashing shall be sheet copper weighing 16 ounces per square foot. Valleys shall be minimum 24 inch wide, 20 ounce copper with a continuous 1½ inch water dam in the center.

Mortar shall be equal to Flexim Roof Mortar as manufactured by Rooftech Roofing Technology Systems.

Accessory Materials:

1. Wood nailing strips (Battens) shall be 2x4, pressure treated in compliance with AWPI and FM Global FR requirements.
2. To attach wood nailing strips to wood decking, use copper, 10 gauge, large headed (5/16" minimum), Slater's ring shank nails or proper length for conditions encountered. Stainless steel screws can be utilized but must meet FM Global's recommendations.

Clay Tile Installation:

1. The installation of clay tile shall be in strict accordance with the manufacturer's written instructions and FM Global's recommendations.
2. Install with a maximum 2" eave overhang.
3. Use hurricane type clips for the first three starter rows.

4. Install nose clips for all clay roof tiles.
5. Use FM recommended pan head type stainless steel screws for attaching clay tiles to batten boards and wood decking. Copper nails of any type shall not allowed.

The Owner reserves the right to engage a qualified testing agency to perform tests and inspections. Any repairs or reasons to remove and replace components of the roofing system where inspections indicate that they do not comply with specified requirements will be performed at Contractor's expense.

FM Global Clay Tile and Plywood Roof Deck Requirements

FM Global does not currently list any approved clay tiles. However, given that Texas Tech University System requires the use of these tiles due to architectural considerations, FM Global can offer the following recommendations.

Clay Tile Securement:
If a Miami Dade County tested tile is being used, in the product approval (NOA) for a Miami Dade County rated tile is the aerodynamic multiplier and the restoring moment due to gravity. Using this NOA information, the RoofCalc pressures, and the Florida Roofing Application Standard 127 you can calculate the resistance (Moment) provided by the various fastening methods in the NOA and compare them against the uplift (Moment). http://www2.iccsafe.org/states/florida%5Fcodes/

However, if a non-Miami Dade County tile is being used, we would simply recommend that all the nail holes be used to secure the tiles with stainless steel pan head type screws ensuring complete embedment through the deck.

Plywood Deck Securement:
Typically, the deck shall be attached to meet local code, but shall not be less than 8d ring shank nails spaced 6" o.c. in the field and 4" o.c. in the 8-ft wide perimeter and corner areas. Ensure plywood fastening is in accordance to FM Global Data Sheet 1-29. Also refer to Division 6 "Wood and Plastics" for roof sheathing requirements. Minimum deck thickness to be 23/32".

If the plywood deck is to be attached to 20-gauge steel joists spaced 2-ft on-center, the following alternative attachment may be used: FM Approved No. 14 fasteners, spaced 1-ft o.c. (minimum 16-fasteners per 4 x 8 sheet of plywood). One example of an FM Approved No. 14 fastener is Olympic (OMG) SIP fastener, No. 14. However, there are certainly others. The key to using an FM Approved fastener is that it is one that not only has a pull-out resistance tested by FM, but also the manufacturing process of approved screws as such that it meets appropriate quality standards for consistency.

Perimeter flashing should be designed and installed in accordance with FM Global Data Sheet 1-49.

Thermoplastic Polyolefin (TPO) Roofing

The TPO roof installation work shall be performed by a single firm specializing in commercial roofing systems and having a minimum of five years' experience in installing TPO roofs of the type specified in this section. The Installer shall be familiar with FM Global requirements and who is approved, authorized, or certified by the membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty. References will be made available upon request.

Specify qualified manufacturers with systems that are UL listed and FM Approved for membrane roofing systems.

Prior to starting work, the roofing contractor shall submit the following minimum items:

1. A sample of the manufacturer's Membrane System Warranty.
2. Submit a letter of certification from the manufacturer which certifies the roofing contractor is authorized to install the manufacturer's roofing system and list foremen who have received training from the manufacturer along with the dates training was received.
3. Certification of the manufacturer's warranty reserve.
4. Completed FM Global "Checklist for Roofing System" form.
5. Completed FM Global RoofNav form.

Upon completion of the installed Work, submit copies of the manufacturer's final warranty to the owner prior to the issuance of final payment.

Provide a minimum manufacturer's total System 15 Year NDL warranty on manufacturer's standard or customized form, covering both labor and materials without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system. Provide a minimum membrane roofing system warranty for wind speeds up to and including 72 mph.

Installed membrane roofing and base flashings shall withstand FM Global specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

Specify membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to the latest revision of ASCE/SEI 7.

1. Corner Uplift Pressure: Per FM Global Requirements.
2. Perimeter Uplift Pressure: Per FM Global Requirements.
3. Field-of-Roof Uplift Pressure: Per FM Global Requirements.

Specify membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approval markings.

1. Fire/Windstorm/Hail Classification: Per FM Global Requirements
2. Hail Resistance: VSH (Very Severe Hail) Class 4 hail rated certificate for All areas excluding El Paso.
3. Hail Resistance SH (Severe Hail) rated certificate for El Paso.

Specify roofing system with initial Solar Reflectance Index not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

Roof decks must be built with a slope of at least ¼-inch per foot toward drains. Dead level roofs are prohibited. Scupper openings through parapet walls or overflow drains shall be provided. Insure that drains are truly at low points of roofed area. Install “crickets or saddles” to divert water flow around curbs so as to avoid interference with designed drainage system.

Roof system shall carry an FM 1-90 rating and UL wind uplift classification Class 90 rating in accordance with UL 580 test procedure, unless the field pressure as calculated by ASCE 7 or FM 1-28 has greater than a 45-psf uplift pressure in the Field. Perimeter and corner enhancements will also be necessary as these pressures will be greater than the Field as calculated by ASCE 7 and FM 1-28. Specified roofing systems should include the FM Global RoofNav Assembly Number of a system in accordance with the wind uplift classification.

TPO roofing material to be fleece back or fabric-reinforced thermoplastic polyolefin sheet meeting ASTM D 6878, with internal fabric or scrim reinforced. Thickness is to be minimum 80 mils, nominal. 60 mils will only be acceptable with the FP&C Project Manager’s approval. Color basis of design shall be white. Tan color shall be used on roofs that are visible to the public.

Specify roof insulation boards and coverboards manufactured or labeled by TPO membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce an FM approved roof system.

Specify factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer. Adhere and heat weld walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

The Owner reserves the right to engage a qualified testing agency to perform tests and inspections. Any repairs or reasons to remove and replace components of the membrane roofing system where inspections indicate that they do not comply with specified requirements will be performed at Contractor's expense.

Texas Tech reserves the right to cut standard size test panels from the finished roof in order to determine that minimum requirements have been met. The roofer shall repair, at his own expense, the roof where test panels were taken.

Coal Tar Elastomeric Membrane (CTEM)

CTEM roofing will only be allowed with the permission from FP&C and the Project Design team. The CTEM roof installation work shall be performed by a single firm specializing in commercial roofing systems and having a minimum of five years' experience in installing CTEM roofs of the type specified in this section. The Installer shall be familiar with FM Global requirements and who is approved, authorized, or licensed by the membrane roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's warranty. References will be made available upon request.

Specify qualified manufacturers with products that are UL listed and FM Approved for membrane roofing systems.

Roof slope: New construction minimum 1/4" per foot in any direction; this includes cross-slopes and crickets. Re-roof minimum IBC 1/4" slope not required; zero slope variance.

Insulation: Minimum 2-layer application with all joints staggered minimum 12"; show material types and thicknesses in Specifications.

All vertical flashing seams shall be hot air welded and become part of manufacturer's twenty (20) year warranty.

The manufacturer's roof warranty is to include manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of the roofing system that fail in materials or workmanship within specified warranty period. Warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate board, roofing accessories, and other components of membrane roofing system. The warranty period is the manufacturer's standard warranty or a minimum of twenty (20) years, whichever is greatest from the date of Substantial Completion. No exclusion for hail events containing hail stones up to and including four inches (4") from the date of substantial completion of the completed project. Manufacturer issuing warranty shall provide historical data supporting hail resistance. Warranty repairs will be performed by a certified installer.

Installed membrane roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Membrane roofing and base flashings shall remain watertight.

CTEM roof system to consist of modified bitumen membrane base ply plus a coal-tar elastomeric finish membrane cap with flood coat and gravel surfacing, complying with UL Class A and ASCE-7 wind uplift criteria.

The coal-tar elastomeric membrane (CTEM) shall be minimum 60 mil overall calendered thickness. The membrane shall be a high-performance elastomeric membrane incorporating a DuPont™ Elvaloy KEE (ketone ethylene ester), extended with coal-tar pitch and reinforced with polyester fibers, or approved equal. The CTEM shall meet the following physical properties: Elongation 170%, ASTM D 412; Tensile Strength 1500 lbs/in^2, ASTM D 412; Tear Strength 330 ppi, ASTM D 624; Density @ 70° F, 80 lbs/ft^3; Low Temperature Flexibility, Pass, 37-GP-56M; and Water Absorption less than 0.1%, 37-GP-56M.
Base flashing shall be same material as the coal-tar elastomeric finish membrane (CTEM) and be installed using the design principles set forth in the National Roofing Contractors Association Manual and details included in Specifications.

Felts shall be Underwriters Laboratory approved and listed in the FM Global Approval Guide and shall be Type IV fiberglass ply sheet, Underwriters Laboratory Type G-1, meeting Federal Specification No. SS-R-620B, ASTM D 2178, Type III, as manufactured by Johns-Manville, or approved equal.

Bitumen shall meet ASTM D-312, Type IV extra steep asphalt.

Insulation shall meet IEC requirements. First layer to be rigid closed-cell polyisocyanurate; long term thermal resistant R-value, FM Class I fire hazard classification, UL classified for installation with Class A roof covering. Second layer to be rigid fiberboard, UL classified for installation with Class A roof covering. Provide additional factory-tapered boards (minimum 1/2" per foot slope) for crickets as shown on roof plan.

Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

Specify membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.

1. Corner Uplift Pressure: Per FM Global Requirements.
2. Perimeter Uplift Pressure: Per FM Global Requirements.
3. Field-of-Roof Uplift Pressure: Per FM Global Requirements.

Specify membrane roofing, base flashings, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a membrane roofing system, and that are listed in FM Approvals' "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approval markings.

1. Fire/Windstorm Classification: Per FM Global Requirements
2. Hail Resistance: SH (Severe Hail) or VSH (Very Severe Hail) determined by project location.

Roof system shall carry a UL wind uplift classification Class 90 rating in accordance with UL 580 test procedure, unless the field pressure as calculated by ASCE 7 has greater than a 45-psf uplift pressure in the Field. Perimeter and corner enhancements will also be necessary as these pressures will be greater than the Field as calculated by ASCE 7).

The Owner reserves the right to engage a qualified testing agency to perform tests and inspections. Any repairs or reasons to remove and replace components of the membrane roofing system where inspections indicate that they do not comply with specified requirements will be performed at Contractor's expense.

Texas Tech reserves the right to cut test panels from the finished roof in order to determine that minimum requirements have been met. The roofer shall repair, at his own expense, the roof where test panels were taken.

Sheet Metal Flashing and Trim

Sheet metal flashing and trim assemblies as indicated shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

Fabricate and install roof edge flashing capable of resisting the following forces according to recommendations in FM Global's Loss Prevention Data Sheet 1-49.

Submit samples for Initial selection for each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes involving color selection.

When specified by the Design Professional or directed by Owners Representative, before beginning installation of sheet metal flashing and trim, build a mockup to verify selections made under sample submittals and to demonstrate aesthetic effects and quality standards.

Sheet metal flashing and trim shall comply with SMACNA's "Architectural Sheet Metal Manual" the National Roofing Contractors Association's (NRCA) criteria, and the manufacturer's requirements, unless more stringent requirements are specified or shown on drawings.

Copper sheet metal shall comply with CDA's "Copper in Architecture Handbook" unless more stringent requirements are specified or shown on drawings.

Custom fabricate sheet metal flashing and trim to comply with the latest edition in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

Manufacturer shall agree under warranty to repair, finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within twenty (20) years of Substantial Completion.

Copper sheet to be: ASTM B 370, cold-rolled copper sheet, H00 or H01 temper.

1. Non-patinated Exposed Finish: Mill.

Metallic-coated steel sheet to be: Restricted flatness steel sheet, metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A 755/A 755M.

1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 coating designation; structural quality.
2. Surface: Smooth, flat.
3. Exposed Coil-Coated Finish:
    a. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
4. Color: As selected by Architect from manufacturer's full range, including metallic coatings.
5. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.

Fabricate hanging gutters to cross section indicated, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 8 foot long sections but not to exceed 12 feet. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice the gutter thickness. Gutter anchors at max. 3'-0" OC with gutter expansion joints every 50 feet and downspout anchors maximum at 6'-0" OC. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters. Specifying cast downspout boots unless waived by the TTU FP&C PM.

1. Gutter Style: SMACNA designation K
2. Expansion Joints: Expansion joints should be installed to comply with the SMACNA Architectural Sheet Metal Manual.
3. Leaf Screen: If specified, provide continuous removable leaf screen with sheet metal frame and hardware cloth screen.
4. Gutters with Girth 20 inches or less: Fabricate from the following materials:

a. Copper: 16 oz. /sq. ft.

5. Gutters with girth of 20 to 25 inches: Fabricate from the following materials:
    a. Copper: 20 oz./sq. ft.
6. Gutters with Girth 25 to 35 Inches: Fabricate from the following materials:
    a. Copper: 24 oz./sq. ft.
7. Corners to be factory mitered and soldered or continuously welded.
8. Gutters are to have flat ends.

Fabricate rectangular downspouts complete with mitered elbows. Furnish with metal hangers, from same material as downspouts, and anchors.

1. Fabricate from the following materials:
    a. Copper: 16 oz./sq. ft.

For Opening Flashings in Frame Construction, fabricate head, sill, jamb, and similar flashings to extend 4 inches beyond wall openings. Form head and sill flashing with 2-inch high, end dams. Fabricate from:

1. Copper: 16 oz./sq. ft.

Use of pitch pans or pockets is prohibited. Items penetrating roofing must be flashed with sheet metal secured with clamps or with ten (10) inches high box curbs welded, or otherwise secured, to the penetrating items. Provide continuous cleats (FM 1-49).

Roof Specialties and Accessories

Submit for each exposed product and for each color and texture specified, prepared on samples of size to adequately show color.

When roof hatches are required, specify metal roof-hatch units, single leaf, with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, meeting appropriate fire rating, continuous lid-to-curb counterflashing and weather tight perimeter gasketing, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom. Roof hatches to be single leaf lid, 36”X30” minimum size with a ladder-assist post when required. Show details on the Drawings. Show all locations on Roof Plan Drawings.

Roof curbs to be minimum 18-gauge galvanized steel (heavier if required for specific equipment), integrally welded, pressure-treated wood nailers, raised cant integral with curb (size to match roof insulation), and minimum 1-1/2" rigid fiberglass insulation.

Where required, expansion joints shall use 3 dimensional bellows in order to accommodate x,y, and z, directional building movement.

Through Penetration Firestop Systems

The Contractor shall install approved UL firestopping systems where required. Firestop products shall be FM Global approved.

The Contractor shall submit UL Firestopping systems and FM approved products for approval.

The Project Design Professional shall incorporate UL firestopping details into the Contract Documents.

Owner reserves the right to engage a qualified testing agency to perform tests and inspections. Where deficiencies are found or penetration firestopping is damaged or removed because of testing, repair or replace penetration firestopping to comply with requirements. Proceed with enclosing penetration firestopping with other construction only after inspection reports are issued and installations comply with requirements.

Joint Sealants

Submit product data indicating sealant chemical characteristics, MSDS sheets, performance criteria, installation instructions, warranty information, limitations and color availability.

Submit four sample kits in form of manufacturer's standard bead samples, consisting of strips of actual products showing full range of colors available, for each product exposed to view.

Submit manufacturer's certificate that products meet or exceed specified requirements and are suitable for use indicated.

Specify a manufacturer specializing in manufacturing the products specified in this Section with minimum ten years documented experience.

Submit an applicator specializing in applying the work of this Section with minimum five years documented experience. References will be made available upon request.

Conform to ASTM C1193 requirements for materials and installation.

Obtain joint sealant materials from a single manufacturer for each different product required.

Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

A field adhesion test shall be performed prior to installation of the sealant to determine whether priming may be necessary, as well as to confirm project specific substrates adhesion.

Joint schedule to be defined as:

1. Exterior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces:
    a. Joints between plan-precast architectural concrete units.
    b. Control and expansion joints in unit masonry.

c. Joints between metal panels.
d. Joints between different materials listed above.
e. Perimeter joints around frames of doors, windows, and louvers.
f. Control and expansion joints in ceilings and other overhead surfaces.

2. Exterior Joints in Horizontal Traffic Surfaces:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Isolation and contraction joints in cast-in-place concrete slabs.
   c. Joints between different materials listed above.
3. Interior Joints in Vertical Surfaces and Horizontal Nontraffic Surfaces:
   a. Control and expansion joints on exposed interior surfaces of exterior walls.
   b. Perimeter joints of exterior openings.
   c. Control and expansion joints in tile.
   d. Vertical joints on exposed surfaces of interior unit masonry walls.
   e. Joints on underside of plant-precast structural concrete planks.
   f. Perimeter joints between interior wall surfaces and frames of interior doors, windows, and elevator entrances.
   g. Joints between plumbing fixtures and adjoining walls, floors, and counters.
4. Interior Joints in Horizontal Traffic Surfaces: (No Silicone at foot traffic areas)
   a. Isolation joints in cast-in-place concrete slabs.
   b. Control and expansion joints in brick and tile flooring.

If masonry joint sealant is used, the Design Professional shall specify DOW 756 product. If requested, catalog colors will be an option to the Owner at no additional cost.

Do not use silicone at foot traffic areas.

Apply sealants as late as possible in the construction, preceding painting, and following cleaning operations. Do not apply sealants when air temperature is below 40 degrees F.

Provide a written guarantee that the Contractor and the sealant installer jointly guarantee to replace, at no cost to Texas Tech, any or all joints which fail within 5-years after acceptance.