

SECTION 075423 - THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Adhered TPO membrane roofing system.
 - 2. Substrate boards.
 - 3. Vapor barrier.
 - 4. Roof insulation.
 - 5. Cover boards
 - 6. Miscellaneous accessories
 - 7. Walkway products.
- B. Related Sections:
 - 1. Division 05 Section "Steel Decking" for furnishing acoustical deck rib insulation.
 - 2. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
 - 3. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof penetration flashings, flashings, and counterflashings.
 - 4. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
 - 5. Division 22 Section "Storm Drainage Piping Specialties" for roof drains.

1.2 DEFINITIONS

- A. TPO: Thermoplastic polyolefin.
- B. Roofing Terminology: Refer to ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.
- C. Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," before multiplication by a safety factor.
- D. Factored Design Uplift Pressure: The uplift pressure, calculated according to procedures in SPRI's "Wind Load Design Guide for Fully Adhered and Mechanically Fastened Roofing Systems," after multiplication by a safety factor.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Provide installed membrane roofing and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure. Membrane roofing and base flashings shall remain watertight.

- B. **Material Compatibility:** Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing system manufacturer based on testing and field experience.
- C. **Roofing System Design:** Provide membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspection agency to resist wind uplift pressure calculated according to ASCE/SEI 7 and identified on Structural Drawings. Completed Work shall withstand the design wind pressure, as follows:
 - 1. Corner Uplift Pressure: -107.7 lbf/sq. ft. (kPa/sq. m).
 - 2. Perimeter Uplift Pressure: -71.5 lbf/sq. ft. (kPa/sq. m).
 - 3. Field-of-Roof Uplift Pressure: -42.6 lbf/sq. ft. (kPa/sq. m).
- D. **FM Approvals Listing:** Provide 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 Approvals markings.
 - 1. Fire/Windstorm Classification: Class 1A-120.
 - 2. Hail Resistance: SH.
- E. **Energy Performance:** Provide 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.
- F. **Thermal Barrier:** Design, fabricate and install insulated membrane roofing system with continuous insulation to provide a thermal barrier. Provide thickness of insulation required to achieve a minimum effective thermal R-value of 24; U value of 0.042. Provide additional insulation thickness to compensate for losses in insulation value due to supports, configuration, gaps and tolerances within roof assemblies.
- G. **Fasteners:** Fasteners shall be capable of resisting a minimum pull-out force of 800 lbs. (3600N) when tested in accordance with ANSI/SPRI FX-1 for metal deck and ASTM E488 for concrete deck.

1.4 ACTION SUBMITTALS

- A. **Product Data:** For each type of roofing product indicated. Include data substantiating that materials comply with requirements.
- B. **Shop Drawings:** Submit shop drawings for specified roofing system. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Outline of each roof or roof area, number for reference, showing the location and type of all penetrations, location of and type of seams and keyed locations for all details.
 - 2. Base flashings and membrane terminations.
 - a. Include flashing details for each flashing condition. Indicate flashing detail locations on roof plan.
 - b. Indicate complete installation details of roofing and flashing, including roof slopes, flashing details, penetration details and accessories.
 - c. Furnish project-specific details; manufacturer's standard pre-printed details will not be acceptable Shop Drawings.
 - 3. Tapered insulation, including slopes.

4. Insulation Crickets, Saddles and Tapered System: Shop drawings showing layout, dimensions, slopes, details and method of attachment to substrate.
 5. Insulation fastening patterns for corner, perimeter, and field-of-roof locations necessary to satisfy windstorm classification rating specified.
 6. Perimeter and penetration details, including methods of attachment, additional membrane securement bars and strips, splices, sizes, spacing and types of all anchors and fasteners.
 7. Walkway Pavers: Shop drawings of each roof or roof area showing the layout and pattern of pavers, indicate paver weights and areas of coverage, pavers requiring cutting, special or addition anchorage details. Show all roof mounted equipment, projections and penetrations thru the pavers.
 8. Walkway Pads: Shop drawings of each roof or roof area showing the layout and pattern of walkway pads, indicate pads requiring cutting, special or addition installation details. Show all roof mounted equipment, projections and penetrations thru the walkway pads.
- C. Samples for Verification: For the following products:
1. Sheet roofing, of color specified, including T-shaped side and end lap seam, 12-by-12-inch (300-by-300-mm) square .
 2. Roof insulation, 12-by-12-inch (300-by-300-mm) square.
 3. Roof paver, full sized, in each color and texture required.
 4. Walkway pads or rolls, 12 inch square.
 5. Metal termination bars, 12 inch long.
 6. Six insulation fasteners of each type, length, and finish.

1.5 INFORMATIONAL SUBMITTALS

- A. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
- B. Qualification Data: For qualified Installer and manufacturer to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- C. Manufacturer Certificates: Signed by roofing system manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 1. Submit evidence of compliance with performance requirements.
- D. Product Test Reports: Based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified testing agency, for components of membrane roofing system.
- E. Research/Evaluation Reports: For components of membrane roofing system, from the ICC-ES.
- F. Field quality-control reports.
- G. Warranties: Sample of special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.
 - 1. Field Seams: After installation is completed, submit 2 copies of inspection and testing report prepared by the single ply membrane manufacturer and countersigned by the applicator, outlining the testing and inspection procedures and attesting to the fact that the single ply membrane field seams including the expansion joints, were 100% inspected and tested.
 - 2. Fastener Pull-Out Tests: After installation is completed, submit 2 copies of test report, outlining test procedures, test results and remedial actions taken, if required.
- B. Water Tests: After installation is completed, submit 2 copies of test report, outlining test procedures, test results and remedial actions taken, if required.
- C. Manufacturer's Acceptance Certification: Upon completion of the Work submit a written certified statement signed by the manufacturer stating that the field supervision by the manufacturer's representative was sufficient to insure proper application of the materials, that the Work was installed in accordance with the Contract Documents and that the installation is acceptable to the manufacturer and in compliance with specified warranty requirements.
- D. Maintenance Manuals: For roofing system to include in the maintenance manuals, submit two (2) sets of manufacturer's printed instructions and recommendations for proper maintenance of the specified roof system including inspection frequencies, penetration addition policies, temporary repairs, and leak call procedures.
- E. Warranty: Copy of executed warranty stating obligations, remedies, limitations, and exclusions of warranty.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is for membrane roofing system identical to that used for this Project.
- B. Installer Qualifications: Engage an experienced installer, with 5 years successful experience on projects of comparable size and scope to this Project, to perform work of this Section and who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.
- C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.
- D. Source Limitations: Obtain components for membrane roofing system from or approved by membrane roofing manufacturer.
- E. Exterior Fire-Test Exposure: Provide roofing system for application and roof slopes indicated, with fire test response characteristics indicated as determined by testing identical roofing system in accordance with UL, FMG, or other testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing agency.

1. Exterior Fire-Test Exposure: Class A; ASTM E 108, for application and roof slopes indicated.
 - F. Reference Standards: Comply with the applicable provisions of the referenced standards except as modified by governing codes and the Contract Documents.
 1. Single Ply Roofing Institute (SPRI):
 - a. Wind Load Design Guide For Low Sloped Flexible Membrane Roofing Systems
 - b. Fastener Selection Guide
 - c. ANSI/SPRI FX-1 Standard Field Test Procedure for Determining the Withdrawal Resistance of Roofing Fasteners.
 - d. ANSI/SPRI ES-1 Wind Design Guide For Edge Systems Used With Low Slope Roofing Systems
 2. National Roofing Contractor's Association (NRCA): Roofing and Waterproofing Manual.
 3. Factory Mutual Group (FMG)
 - a. FMG 4450: Approval Standard for Class 1 "Insulated Steel Deck Roofs".
 - b. FMG 4470: Approval Standard Class 1 "Roof Covers"
 - c. FMG "Approval Guide"
 - G. Preinstallation Roofing Conference: Before installing roofing system, conduct conference at Project site to comply with requirements of Division 01 Section "Project Management and Coordination."
 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 3. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 5. Review structural loading limitations of roof deck during and after roofing.
 6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
 7. Review governing regulations and requirements for insurance and certificates, inspection and testing, if applicable.
 8. Review temporary protection requirements for roofing system during and after installation.
 9. Review roof observation and repair procedures after roofing installation.
 10. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of

manufacture, approval or listing agency markings, and directions for storing and mixing with other components.

- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.9 PROJECT CONDITIONS

- A. Weather Limitations: 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.
- B. Emergency Equipment: Maintain on-site equipment necessary to apply emergency temporary edge seal in the event of sudden storms or inclement weather.
- C. Coordinate between various trades to avoid unnecessary rooftop traffic over sections of the roof and to prevent damage to the membrane. Heavily traveled areas shall be protected by placing temporary protection courses to prevent damage to the membrane.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard or customized form, 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. Failure includes roof leaks.
 - 1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, roofing accessories, vapor barrier, walkway products, and other components of membrane roofing system.
 - 2. Include agreement to maintain roof and base flashing in a watertight condition for period of warranty. Warranty coverage shall include:
 - a. Base ply materials, fasteners and adhesives.
 - b. Roof membrane components and adhesives.
 - c. All accessory products required for installation of membrane roofing system, including flashing plies and vapor retarder.
 - d. Roof insulation, substrate boards, cover boards, and fasteners.
 - 3. Warranty shall not exclude coverage as a result of winds of 80 m.p.h. or less.
 - 4. Warranty Period: 20 years from date of Substantial Completion.
- B. Special Warranty for Polyisocyanurate Insulation: Upon completion of the work, provide polyisocyanurate insulation manufacturer's twenty (20) year warranty stating that the thermal resistance of the insulation shall not vary more than 20% from its published value. Upon notification of such defects, within the warranty

period, make the necessary repairs or replacements, including cost of materials and labor, at the convenience of the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Regional Materials: Provide a minimum of 20 percent of building materials (by cost) that are regionally extracted, processed and manufactured materials within a radius of 500 miles.
- B. Provide products recommended by manufacturers to be fully compatible with each other and with indicated substrates, or provide separation materials as required to eliminate contact between incompatible materials.

2.2 TPO MEMBRANE ROOFING

- A. Fabric-Reinforced Thermoplastic Polyolefin Sheet: ASTM D 6878, internally fabric or scrim reinforced, uniform, flexible fabric backed TPO sheet.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following :
 - a. "Sure-Weld TPO" (Carlisle SynTec Incorporated).
 - b. "Ultraply TPO" (Firestone Building Products Company).
 - c. "EverGuard TPO" (GAF Materials Corporation).
 - d. "GenFlex TPO HY" (GenFlex Roofing Systems).
 - e. "Tiempo 2000+TPO" (Dow Roofing).
 - f. "Versiweld TPO Fully Adhered Membrane" (Versico Incorporated).
 - 2. Thickness: 60 mils (1.5 mm), nominal.
 - 3. Exposed Face Color: Gray. (Energy Star Rated).
 - 4. Physical Properties:
 - a. Breaking Strength: 225 lbf(1 kN); ASTM D 751, grab method.
 - b. Elongation at Break: 15 percent; ASTM D 751.
 - c. Tearing Strength: 55 lbf(245 N) minimum; ASTM D 751, Procedure B.
 - d. Brittleness Point: Minus 22 deg F(30 deg C).
 - e. Ozone Resistance: No cracks after sample, wrapped around a 3-inch-(75-mm-) diameter mandrel, is exposed for 166 hours to a temperature of 104 deg F(40 deg C) and an ozone level of 100 pphm(100 mPa); ASTM D 1149.
 - f. Resistance to Heat Aging: 90 percent minimum retention of breaking strength, elongation at break, and tearing strength after 166 hours at 240 deg F(116 deg C); ASTM D 573.
 - g. Water Absorption: Less than 4 percent mass change after 166 hours' immersion at 158 deg F(70 deg C); ASTM D 471.
 - h. Linear Dimension Change: Plus or minus 2 percent; ASTM D 1204.
- B. Roofing System Assemblies: Provide the following roofing system assembly complete with fasteners and accessories to comply with performance criteria:
 - 1. Complete TPO assembly, including thermoplastic polyolefin sheet, flashing, edge lap sealant, substrate membrane adhesive, mastics, thinners, sealers, release agents, sheet activators, sheet primers and solvents; insulation board, tapered insulation, sheathing board, vapor barrier membrane

termination bars, vent and pipe clamping rings, fasteners and other accessories recommended by roof membrane manufacturer for a complete system.

2.3 AUXILIARY MEMBRANE ROOFING MATERIALS

- A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
 - 2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.
 - d. Fiberglass Adhesives: 80 g/L.
 - e. Contact Adhesive: 80 g/L.
 - f. Other Adhesives: 250 g/L.
 - g. Single-Ply Roof Membrane Sealants: 450 g/L.
 - h. Nonmembrane Roof Sealants: 300 g/L.
 - i. Sealant Primers for Nonporous Substrates: 250 g/L.
 - j. Sealant Primers for Porous Substrates: 775 g/L.
- B. Sheet Flashing: Manufacturer's standard unreinforced thermoplastic polyolefin sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as sheet membrane.
- C. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
- D. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG Approvals 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.
- E. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories recommended by roofing system manufacturer for intended use.

2.4 SUBSTRATE BOARDS

- A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, Type X, 5/8 inch (16 mm) thick.
 - 1. Products: Subject to compliance with requirements, provide the following:
 - a. Georgia-Pacific Corporation; Dens Deck.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.

2.5 VAPOR BARRIER

- A. Reinforced-Polyethylene Vapor Retarders: Two outer layers of polyethylene film laminated to an inner reinforcing layer consisting of either nylon cord or polyester scrim and weighing not less than 25 lb/1000 sq. ft. (12 kg/100 sq. m), with maximum permeance rating of 0.0507 perm (2.9 ng/Pa x s x sq. m).
1. Products: Subject to compliance with requirements, provide the following:
 - a. Reef Industries, Inc.; Griffolyn T-65.

2.6 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by TPO membrane roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Approvals-approved roof insulation.
- B. Extruded-Polystyrene Board Insulation: Rigid, closed cell extruded with integral high density skin complying with ASTM C 578, Type IV, 1.6-lb/cu. ft. (26-kg/cu. m) with a minimum density of 40 psi. Provide both tapered and fill type insulation which shall be assembled into a system with a slope no less than 1/4 in. per foot with a starting thickness at the drains of 1 in. Mark the individual tapered insulation boards with an appropriate code to denote its configuration, slope, and arrow pointing in direction of the drain. Provide one of the following:
1. Tapered Insulation
 - a. "Tapered Styrofoam Highland 40" (The Dow Chemical Co.).
 - b. "Tapered Foamular 400" (Owens-Corning Corp.).
 2. Fill Insulation
 - a. "Styrofoam Highland 40" (The Dow Chemical Co.).
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of necessary to achieve finished roof slope of 1/4 inch per 12 inches (1:48)] unless otherwise indicated. Fabricate of same material as primary insulation.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated and of same material as primary insulation.

2.7 INSULATION ACCESSORIES

- A. General: Furnish roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with membrane roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FMG 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 5/8 inch (16 mm) thick.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Georgia-Pacific Corporation; Dens Deck.

- D. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric mat, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

2.8 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch (5 mm) thick, white color, and fabricated by membrane roofing system manufacturer to have excellent tear, puncture, and weather resistance.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with the following requirements and other conditions affecting performance of roofing system:
 - 1. Verify that roof openings and penetrations are in place set and braced and that roof drains are properly clamped in position.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
 - 4. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 5. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday
 - 1. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
 - 2. If roof drains will be temporarily blocked or unserviceable due to partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under membrane roofing system components.
- C. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of the roofing system at the end of the

workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.3 VAPOR-RETARDER INSTALLATION

- A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 4 inches (100 mm) and 6 inches (150 mm), respectively.
 - 1. Continuously seal side and end laps with manufacturer's recommended tape or adhesive.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into membrane roofing system.

3.4 INSULATION INSTALLATION

- A. Coordinate installing membrane roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with membrane roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.5 inches (63 mm) or greater, install two or more layers with joints of each succeeding layer staggered from joints of previous layer a minimum of 6 inches (150 mm) in each direction.
 - 1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
 - 2. Do not install more insulation each day that can be covered with the membrane before the end of day and before start of inclement weather.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
 - 1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
- G. Mechanically Fastened Insulation: Install each layer of insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation according to requirements in FMG's "ApprovalGuide" for specified Windstorm Resistance Classification.
- H. Mechanically Fastened and Adhered Insulation: Install each layer of insulation and secure first layer of insulation to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten first layer of insulation according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.

2. Fasten first layer of insulation to resist uplift pressure at corners, perimeter, and field of roof.
 3. Set each subsequent layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 4. Set each subsequent layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.
- I. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck in a uniform coverage of full spread adhesive, firmly pressing and maintaining boards in place.
1. Fasten cover boards according to requirements in FMG's "Approval Guide" for specified Windstorm Resistance Classification.

3.5 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere membrane roofing over area to receive roofing and install according to membrane roofing system manufacturer's written instructions, for a complete, water-tight installation.
1. Unroll roofing membrane and allow to relax before installing.
- B. Start installation of membrane roofing in presence of membrane roofing system manufacturer's technical personnel.
- C. Accurately align membrane roofing and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- D. Bonding Adhesive: Apply to substrate and underside of membrane roofing at rate required by manufacturer and allow to partially dry before installing membrane roofing. Do not apply to splice area of membrane roofing.
- E. In addition to adhering, mechanically fasten membrane roofing securely at terminations, penetrations, and perimeter of roofing.
- F. Apply the single-ply membrane in the longest lengths possible. Adhere membrane to insulation overlayment in a continuous bed of adhesive. Install membrane free from bubbles, wrinkles, folds or other surface defects. In addition to the full bed of adhesive, provide mechanical fasteners at terminations and perimeter to assure compliance with wind uplift requirements.
- G. Lap seams in the direction of drainage Apply membrane roofing with side laps shingled with slope of roof deck where possible. Provide smooth flat seams free from bubbles, wrinkles, folds or other surface defects. Apply a continuous bead of edge lap sealant to seams and joints which have had the factory edge cut or abraded.
- H. Seams: Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.
1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet membrane.
 2. Verify field strength of seams a minimum of twice daily and repair seam sample areas.

3. Repair tears, voids, and lapped seams in roofing that does not comply with requirements.
 - I. Spread sealant bed over deck drain flange at roof drains and securely seal membrane roofing in place with clamping ring.
 - J. Metal Work: At terminations and penetrations, set metal flanges in adhesive mastic. Strip metal flanges with flashing membrane set-in adhesive. Seal selvages, seams and joints. Where membrane or flashings terminate against parapet walls, curbs, pipe and vent penetrations and other such obstructions, provide termination bars and pipe clamping rings. Provide continuous sealant bead at top of termination bars and clamping rings.
 1. Install membrane at terminations, penetrations, preformed curbs, dunnage, parapets and other interruptions of the roofing membrane. Provide mechanical fasteners, flashings counterflashings and accessories at recommended locations. Provide temporary seals and night seals to protect the insulation and the building interior.
 2. Roofing Metal Work (Other than Roof System Metalwork): Be responsible for the proper attachment of specified work to roofing metal or related work that is embedded in, or in contact with, and becomes an integral part of specified roofing or flashing system, even when such roofing metal or related work is provided under other Sections of the Specifications.
 - K. Expansion Joints: Install expansion joints to ensure a complete watertight installation. Expansion joints shall be considered part of roofing system and shall be warranted as specified herein.
- 3.6 BASE FLASHING INSTALLATION
 - A. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.
 - B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry. Do not apply to seam area of flashing.
 - C. Flash penetrations, perimeter gravel stop fascias, parapets, walls, around vents, curbs, and field-formed inside and outside corners, and other roof penetrations with membrane sheet flashing. Use longest practicable length of membrane.
 - D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.
 1. Take measures to ensure flashing does not ridge where there is change of direction.
 - E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars and mechanically anchor to substrate through termination bars.
 - F. Deflection Compensation at Parapet Walls:
 1. Install filler rod at junction of roof and parapet walls.
 2. Do not bond rod filler to membrane or base flashing material. Do not allow adhesives in contact with rod filler.

3.7 WALKWAY INSTALLATION

- A. Flexible Walkways: Install walkway products at all traffic concentration points (roof hatches, access doors, rooftop ladders), in locations where regular maintenance (once a month or more) is necessary to service rooftop equipment, and in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.8 FIELD QUALITY CONTROL

- A. Owner's Testing Agency: Contractor shall engage a qualified testing and inspecting agency to monitor the Contractor's Quality Control tests and inspections, and prepare reports.
 - 1. The monitoring activities do not relieve the Contractor of responsibilities under the Contract. The Contractor is solely responsible for quality control of the Work.
- B. Manufacturer's Technical Representative: At the start of the installation and periodically as work progresses provide the services of the manufacturer's technical representative at the job site as often as deemed necessary by the manufacturer to advise on phases of this work.
- C. Contractor's Field Quality Control Material Testing
 - 1. Field Seams: Provide inspection and testing of the field seams to assure manufacturer's quality requirements are maintained throughout the installation period. Inspect 100 percent of each field seam including expansion joints in the presence of the membrane manufacturer's representative. Obtain manufacturer's written report and submit for review prior to final acceptance.
 - 2. Fasteners: Provide one fastener pull out test for every 2,500 sq. ft. of roofing for the first 50,000 sq. ft. of roofing, and one for each 5,000 sq. ft. above the first 50,000 sq. ft., verifying the integrity of the fasteners and compliance with the specified performance criteria.
 - 3. Insulation Bubble Testing: Comply with FM Global's bubble test for roof insulation field mockup. Coordinate size and location of mockup with FM Global. Perform an uplift test in accordance with FM Global Data Sheet 1-52 on roof mockup.
- D. Field Water Test
 - 1. Water Flood Testing: Immediately after installation of roofing system, and before the aggregate and pavers are installed, dam each area designated by the Architect and subject entire system to a flood test of minimum 2 in. of water for not less than 48 hours. Conduct testing on each area as the Work progresses. Test 100% of the roof membrane. After the water has been removed, repair leaks and protect the accepted segment.
- E. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, and submit report to the Architect.
- F. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

- G. Additional testing and inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.9 ADJUSTMENT, PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates. Repair or reinstall so that entire membrane roofing system is free of damage and deterioration at time of Substantial Completion and in compliance with warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.10 ROOFING INSTALLER'S WARRANTY (Example)

- A. WHEREAS <Insert name> of <Insert address>, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:
 - 1. Owner: <Insert name of Owner>.
 - 2. Address: <Insert address>.
 - 3. Building Name/Type: <Insert information>.
 - 4. Address: <Insert address>.
 - 5. Area of Work: <Insert information>.
 - 6. Acceptance Date: <Insert date>.
 - 7. Warranty Period: 20 Years.
 - 8. Expiration Date: <Insert date>.
- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
 - 1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. Lightning;
 - b. Peak gust wind speed exceeding <Insert wind speed> mph (m/sec);
 - c. Fire;
 - d. Failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. Faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;

- f. Vapor condensation on bottom of roofing; and
 - g. Activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof has been paid by Owner or by another responsible party so designated.
 3. The Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents, resulting from leaks or faults or defects of work.
 4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
 6. The Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
 7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.
- E. IN WITNESS THEREOF, this instrument has been duly executed this <Insert day> day of <Insert month>, <Insert year>.
1. Authorized Signature: <Insert signature>.
 2. Name: <Insert name>.
 3. Title: <Insert title>.

END OF SECTION