SECTION 075423 - THERMOPLASTIC-POLYOLEFIN (TPO) ROOFING

Revise this Section by deleting and inserting text to meet Project-specific requirements.

MasterSpec includes provisions for LEED 2009, LEED v4, IgCC, and Green Globes. Sustainable design requirements may be inserted in the Section Text using the hypertext links.

1. GENERAL
	* + 1. SUMMARY
				1. Section Includes:

**[Adhered] [Self-adhering] [Mechanically fastened] [Induction welded] [Loosely laid and ballasted]** thermoplastic polyolefin (TPO) roofing system.

Accessory roofing materials.

Substrate board.

Vapor retarder.

Roof insulation.

Insulation accessories and cover board.

Asphalt materials.

Electronic leak detection (ELD) materials.

Ballast.

Walkways.

Retain first paragraph below if acoustical roof deck is required and if installation of insulation strips is included in this Section.

* + - * 1. Section includes installation of sound-absorbing insulation strips in ribs of roof deck. Sound-absorbing insulation strips are furnished under Section 053100 "Steel Decking."

Refer to sections listed below for cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections. Sections listed below are for spec editor’s and design team coordination and are to remain as Editor’s Notes. Remove referenced specification sections within the body of the specification if not applicable to the project.

Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.

Section 061600 "Sheathing" for wood-based, structural-use roof deck panels.

Section 072100 "Thermal Insulation" for insulation beneath the roof deck.

Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.

Section 077100 "Roof Specialties" for [manufactured copings] [and] [roof edge flashings].

Section 077129 "Manufactured Roof Expansion Joints" for manufactured roof expansion-joint assemblies.

Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

Section 221423 "Storm Drainage Piping Specialties" for roof drains.

* + - 1. DEFINITIONS
				1. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to Work of this Section.
			2. PREINSTALLATION MEETINGS

Consider retaining "Preliminary Roofing Conference" paragraph below if roofing installation is large and complicated. A preliminary roofing conference precedes a preinstallation conference and focuses on roof deck construction and planning activities of roofing Installer.

* + - * 1. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site.

Retain subparagraphs below if required. If retaining, revise to include Project-specific requirements. Insert additional requirements to suit Project.

Meet with Director’s Representative,**[ Construction Manager,]** Director’s insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

Review methods and procedures related to roofing installation, including manufacturer's written instructions.

Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

Review deck substrate requirements for conditions and finishes, including flatness and fastening.

Review structural loading limitations of roof deck during and after roofing.

Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.

Review governing regulations and requirements for insurance and certificates if applicable.

Review temporary protection requirements for roofing system during and after installation.

Review roof observation and repair procedures after roofing installation.

Retain "Preinstallation Roofing Conference" paragraph below if Work of this Section is extensive or complex enough to justify a conference. paragraph is recommended with or without "Preliminary Roofing Conference" above.

* + - * 1. Preinstallation Roofing Conference: Conduct conference at Project site.

Retain subparagraphs below if required. If retaining, revise to include Project-specific requirements. Insert additional requirements to suit Project.

Meet with Director’s Representative,**[ Construction Manager,]** Director’s insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

Review methods and procedures related to roofing installation, including manufacturer's written instructions.

Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.

Review structural loading limitations of roof deck during and after roofing.

Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.

Review governing regulations and requirements for insurance and certificates if applicable.

Review temporary protection requirements for roofing system during and after installation.

Review roof observation and repair procedures after roofing installation.

* + - 1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product.

First option in subparagraph below applies only to concrete, lightweight insulating concrete, and steel roof decks. Second option applies to concrete, lightweight insulating concrete, cementitious wood fiber, steel, and wood roof decks. See the Evaluations.

For insulation and roof system component fasteners, include copy of **[FM Approvals' RoofNav] [SPRI's Directory of Roof Assemblies]** listing.

Include manufacturer’s installation instructions.

* + - * 1. Sustainable Design Submittals:

* + - * 1. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:

Layout and thickness of insulation.

Base flashings and membrane termination details.

Flashing details at penetrations.

Retain one or more subparagraphs below.

Tapered insulation layout, thickness, and slopes.

Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.

Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

Tie-in with adjoining air barrier.

* + - * 1. Samples for Verification: For the following products:

Retain one or more subparagraphs below.

Roof membrane and flashings, of color required.

Aggregate ballast in gradation**[ and color]** required.

Roof paver**[, full sized,]** in each color and texture required.

Walkway pads or rolls, of color required.

* + - * 1. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.
				2. Quality Control Submittals:

Qualification Data: For [Installer] [manufacturer] [and] [testing agency].

Manufacturer Certificates:

Retain "Performance Requirement Certificate" subparagraph below if retaining "FM Approvals' RoofNav Listing," "SPRI's Directory of Roof Assemblies Listing," or "Energy Performance" paragraph in "Performance Requirements" Article.

Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

Submit evidence of compliance with performance requirements.

Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.

Product Test Reports: For roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.

Evaluation Reports: For components of roofing system, from ICC-ES.

Design Consultant to review code references and verify that the referenced sections/tables are current. Note that code references shall be based on the current version of the Uniform Code.

Retain "Field Test Reports" paragraph below when applicable.

Field Test Reports:

First subparagraph below is for concrete roof decks. Second subparagraph is for roof decks requiring fastener-pullout test.

Concrete internal relative humidity test reports.

Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

Field quality-control reports.

Sample Warranties: For manufacturer's special warranties.

* + - * 1. Contract Closeout Submittals

Maintenance Data: For roofing system to include in maintenance manuals.

Retain paragraph below for projects that include existing buildings with warranted roof systems interfacing with the Work of this Section.

Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

* + - 1. QUALITY ASSURANCE
				1. Qualifications:

Second option in "Manufacturers" subparagraph below applies only to concrete, lightweight insulating concrete, and steel roof decks. Third option applies to concrete, lightweight insulating concrete, cementitious wood fiber, steel, and wood roof decks. See the Evaluations.

Manufacturers: A qualified manufacturer that is **[UL listed] [listed in FM Approvals' RoofNav] [listed in SPRI's Directory of Roof Assemblies]** for roofing system identical to that used for this Project.

Installers: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

* + - 1. DELIVERY, STORAGE, AND HANDLING
				1. 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.
				2. 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.

Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

* + - * 1. 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.
				2. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.
			1. FIELD CONDITIONS
				1. 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.
			2. WARRANTY

When warranties are required, verify with Director’s Representative that warranties stated in this article are not less than remedies available to the Facility under prevailing local laws.

Retain "Special Warranty" paragraph below if manufacturer's labor-and-materials warranty, covering roofing system, is required. Verify coverage offered by manufacturers, because roof insulation, fasteners, and other roofing components may be excluded unless part of a roof membrane manufacturer's roofing system warranty. If inserting special provisions, retitle paragraph "Special Roofing Manufacturer's Warranty." Verify warranty availability and coordinate selection of manufacturers accordingly.

* + - * 1. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.

Retain options in first subparagraph below based on those used on Project. Verify availability of manufacturer's total-system warranty and components included.

Special warranty includes roof membrane, base flashings, **[roof insulation,] [fasteners,] [cover boards,] [vapor retarder,] [substrate board,] [roof pavers,]** and other components of roofing system.

Verify available warranties and warranty periods.

Warranty Period: **[10] [15] [20] [30] <Insert number>** years from date of Substantial Completion.

If retaining "Special Project Warranty" paragraph below, use or revise sample roofing installer's warranty form at end of this Section. Alternatively, insert reference to local roofing contractor association's warranty form or use another form as advised by Owner's counsel. Revise paragraph to reflect scope of special Project warranty.

* + - * 1. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, **[roof insulation,] [fasteners,] [cover boards,] [substrate boards,] [vapor retarders,] [roof pavers,]** and**[ walkway products]**, for the following warranty period:

Verify available warranties and warranty periods.

Warranty Period: **[Two] <Insert number>** years from date of Substantial Completion.

1. PRODUCTS

Before selecting manufacturers and products, verify availability, suitability for intended applications, and compliance with minimum performance requirements.

Product options commonly available from manufacturers are included in square brackets throughout the Section Text. Not every manufacturer listed can provide every option offered; verify availability with manufacturers.

* + - 1. PERFORMANCE REQUIREMENTS
				1. General Performance: Installed roofing system and flashings to withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roof system and flashings to remain watertight.

Requirements in "Accelerated Weathering" and "Impact Resistance" subparagraphs below are required by the BCNYS for all roof coverings installed on roofs with slopes less than 2:12.

Accelerated Weathering: Roof to withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.

Impact Resistance: Roof membrane to resist impact damage when tested according to ASTM D3746, ASTM D4272, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.

* + - * 1. Material Compatibility: Roofing materials to be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.

Retain "Wind Uplift Resistance" paragraph below for nonballasted roofing systems. See the Evaluations and Roof Wind Designer online software program, or consult structural engineer for determination of wind uplift pressures.

If Project has wood or wood panel roof decks, verify with roofing system manufacturers that test reports are available.

* + - * 1. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to FM Approvals 4474, UL 580, or UL 1897:

Indicate dimensions of perimeter and corners in subparagraphs below for simple roof shapes or indicate on Drawings.

Zone 1 (Roof Area Field): **<Insert lbf/sq. ft.>**.

Zone 2 (Roof Area Perimeter): **<Insert lbf/sq. ft.>**.

Location: From roof edge to **<Insert dimension>** inside roof edge.

Zone 3 (Roof Area Corners): **<Insert lbf/sq. ft.>**.

Location: **<Insert dimension>** in each direction from each building corner.

Retain "FM Approvals' RoofNav Listing" or "SPRI's Directory of Roof Assemblies Listing" paragraphs below, if applicable.

Retain "FM Approvals' RoofNav Listing" paragraph below if Project is FM Global insured or if FM Global requirements set a minimum quality standard. Delete paragraph if roof assembly includes a cementitious wood fiber, wood, or wood panel roof deck because FM Approvals' RoofNav does not include listings for such roof decks. Coordinate requirements in FM Approvals classification with other requirements in this Section. Loosely laid and ballasted roofing systems cannot be approved by FM Approvals but may be accepted on a project-by-project basis. For further clarification, consult FM Approvals.

* + - * 1. FM Approvals' RoofNav Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in FM Approvals' RoofNav for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals Certification markings.

Retain one option in "Fire/Windstorm Classification" subparagraph below based on windstorm classification of Project. Verify availability of roofing systems that comply with these classifications. "Class 1A" signifies compliance with ASTM E108, Class A fire performance for FM Approvals Class 1 roof covers. Almost every TPO membrane will comply with SH rating when installed over the proper cover board.

Fire/Windstorm Classification: **[Class 1A-60] [Class 1A-75] [Class 1A-90] [Class 1A-105] [Class 1A-120] <Insert class>**.

Retain one option in "Hail-Resistance Rating" subparagraph below based on geographical location of Project or desired rating. Verify availability of roofing systems, including specified components, that comply with these ratings using FM Approvals' RoofNav.

Hail-Resistance Rating: FM Global Property Loss Prevention Data Sheet 1-34 **[MH] [SH] [VSH]**.

Retain "SPRI's Directory of Roof Assemblies Listing" paragraph below if SPRI Directory of Roof Assemblies requirements will set a minimum quality standard. Coordinate requirements in "Wind Uplift Load Capacity" subparagraph with other requirements in this Section. Loosely laid and ballasted roofing systems are not included in SPRI's Directory of Roof Assemblies.

* + - * 1. SPRI's Directory of Roof Assemblies Listing: Roof membrane, base flashings, and component materials comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system, and are listed in SPRI's Directory of Roof Assemblies for roof assembly identical for that specified for this Project.

Retain one option in "Wind Uplift Load Capacity" subparagraph below based on windstorm rating of Project. Verify availability of roofing systems that comply with these ratings.

Wind Uplift Load Capacity: **[60 psf] [75 psf] [90 psf] [105 psf] [120 psf] <Insert capacity>**.

Retain applicable "Solar Reflectance Index," "ENERGY STAR Listing," or "Energy Performance" paragraph below if "cool-roof" performance is required. Verify that TPO roof membrane specified complies before retaining.

Retain "ENERGY STAR Listing" paragraph below for roofs that must comply with ENERGY STAR requirements. The DOE's ENERGY STAR "Roof Products Qualified Product List" is available in PDF at www.energystar.gov.

* + - * 1. ENERGY STAR Listing: Roofing system to be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for **[low] [steep]**-slope roof products.

Usually, retain "Energy Performance" paragraph below for roofs that must comply with "California Code of Regulations, Title 24." Options are values required for low-slope roofs by prescriptive approach; revise if other values are required for building-envelope trade-off approach or whole-building performance approach. A list of products tested in accordance with ANSI/CRRC S100, with their test values, is available at www.coolroofs.org.

* + - * 1. Energy Performance: Roofing system to have an initial solar reflectance of not less than **[0.70] <Insert value>** and an emissivity of not less than **[0.75] <Insert value>** when tested in accordance with ANSI/CRRC S100.

Retain one of three options in "Exterior Fire-Test Exposure" paragraph below based on fire classification of roof assembly and roof covering. Delete paragraph if including exterior fire-test exposure in FM Approvals class designation.

* + - * 1. Exterior Fire-Test Exposure: ASTM E108 or UL 790, **[Class A] [Class B] [Class C]**; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

Retain "Fire-Resistance Ratings" paragraph below only if products specified are part of a fire-resistance-rated assembly. Indicate rating, testing agency, and testing agency's design designation on Drawings.

* + - * 1. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.
			1. THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

In "TPO Sheet" paragraph below, coordinate warranty period and membrane thickness if retaining either option. Fabric-backed sheet is available using 45-, 60-, or 80-mil- thick membrane with 55-mil- thick fabric, for a total thickness of 100, 115, or 135 mils Self-adhering membranes are available in 60-mil thickness. Verify that manufacturers offer options retained.

* + - * 1. TPO Sheet: ASTM D6878, internally fabric- or scrim-reinforced, **[fabric-backed] [self-adhering]** TPO sheet.

Retain "Source Limitations" subparagraph below if required to comply with FM Approvals, UL, or provisions of manufacturer's special warranty. Consult roof membrane manufacturer because requirements vary.

Source Limitations: Obtain components for roofing system from **[roof membrane manufacturer] [or] [manufacturers approved by roof membrane manufacturer]**.

Retain one option in "Thickness" subparagraph below. NRCA recommends a minimum thickness of 60 mils.

Thickness: **[45 mils [60 mils] [80 mils] <Insert value>**, nominal.

Retain one option in "Exposed Face Color" subparagraph below.

Exposed Face Color: **[Black] [Gray] [Tan] [White] <Insert color>**.

* + - 1. ACCESSORY ROOFING MATERIALS
				1. General: Accessory materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.

Retain "Adhesive and Sealants" subparagraph below for projects located in jurisdictions where VOC limits are established by statute.

Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.

* + - * 1. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, **[55 mils] <Insert value>** thick, minimum, of same color as TPO sheet.
				2. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
				3. Roof Vents: As recommended by roof membrane manufacturer.

Size: Not less than 4-inch diameter.

Before retaining option in "Bonding Adhesive" paragraph below, verify that roof membrane manufacturers offer a water-based adhesive. Coordinate with selection in "Bonding Adhesive" paragraph in "Adhered Roofing Installation" Article.

* + - * 1. Bonding Adhesive: Manufacturer's standard**[, water based]**.

Retain one of two options in "Slip Sheet" paragraph below if slip sheets are required. See roofing system manufacturer's specifications for requirements. Retain first option over cementitious wood-fiber roof decks if required by roof membrane manufacturer.

* + - * 1. Slip Sheet: **[ASTM D2178, Type IV; glass fiber; asphalt-impregnated felt] [Manufacturer's standard, of thickness required for application]**.

Retain "Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet" paragraph below for lightweight insulating concrete roof decks.

* + - * 1. Asphalt-Coated, Glass-Fiber-Mat, Venting Base Sheet: ASTM D4897, Type II; nonperforated, asphalt-impregnated fiberglass reinforced, with mineral granular patterned surfacing on bottom surface.
				2. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
				3. Metal Battens: Manufacturer's standard, aluminum-zinc-alloy-coated or zinc-coated steel sheet, approximately 1 inch wide by 0.05 inch thick, prepunched.
				4. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.

Fasteners: 1-1/2-inch stainless steel fasteners with neoprene washers.

* + - * 1. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
				2. 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.
			1. SUBSTRATE BOARD

Retain one of first four paragraphs below if required, or delete this article. Substrate boards may serve as building-code-required thermal barriers, separating foam insulation from steel, wood, or wood panel roof decks. They may also be used over steel decks as part of a fire-resistance-rated roofing system or to provide a smooth substrate for a vapor retarder. For fire-rated assemblies, coordinate actual product retained with UL Design Number used. Verify suitability for application. Roof membrane manufacturers do not recognize substrate boards to be part of roofing system.

* + - * 1. Gypsum Board Type X: ASTM C1396.

Thickness: 5/8 inch.

* + - * 1. Glass-Mat Gypsum Roof Substrate Board: ASTM C1177, water-resistant gypsum board.

Thickness: **[1/4 inch] [1/2 inch] [Type X, 5/8 inch]** thick.

Surface Finish: **[Factory primed] [Unprimed]**.

* + - * 1. Fiber-Reinforced Gypsum Roof Board: ASTM C1278, cellulosic-fiber reinforced, water-resistant gypsum board.

Thickness: **[1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch]**.

* + - * 1. Perlite Board: ASTM C728, seal coated.

Thickness: **[3/4 inch ] [1 inch]**.

* + - * 1. 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.
			1. VAPOR RETARDER

Retain this article if a vapor retarder is required. Review compatibility of vapor retarder with other roofing system materials. Coordinate vapor retarder type and installation method with wind uplift requirements. Retain material and installation method to minimize penetrations through vapor retarder. A substrate board or layer of insulation is needed because vapor retarders cannot be placed directly over a steel deck. If necessary, retitle article "Air Retarder" or "Vapor/Air Retarder," depending on function of retarder.

* + - * 1. Polyethylene Film: ASTM D4397, **[6 mils] [10 mils]** thick, minimum, with maximum permeance rating of **[0.13 perm] [0.076 perm]**.

Retain "Tape" or "Adhesive" subparagraph below.

Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

Adhesive: Manufacturer's standard lap adhesive, listed by FM Approvals for vapor retarder application.

"Laminated Sheet Vapor Retarder" paragraph below describes Reef Industries' "Griffolyn Type-55 FR"; revise description to suit another product if required.

* + - * 1. Laminated Sheet Vapor Retarder: Two-layer, fire-retardant polyethylene laminate, reinforced with cord grid.

Permeance Rating: Not more than 0.062 perm when tested in accordance with ASTM E96.

Flame-Spread Index: Not more than 5 when tested in accordance with ASTM E84.

Smoke-Developed Index: Not more than 35 when tested in accordance with ASTM E84.

Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.

* + - * 1. Rubberized-Asphalt-Sheet Vapor Retarder, Self-Adhering: ASTM D1970, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

Retain butyl rubber adhesive for potential use in hot desert or high-altitude climates.

* + - * 1. Butyl-Rubber-Sheet Vapor Retarder, Self-Adhering: Polyethylene film laminated to layer of butyl rubber adhesive, minimum 30-mil total thickness; maximum permeance rating of 0.1 perm; cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.

Retain "Glass-Fiber Felts" paragraph below if a built-up vapor retarder composed of felts and hot asphalt is required.

* + - * 1. Glass-Fiber Felts: ASTM D2178, Type IV; asphalt impregnated.
			1. ROOF INSULATION

If retaining more than one insulation material in this article, indicate location of each on Drawings or indicate where each layer is used in roofing system. Coordinate insulation selection and thicknesses with adjoining construction as well as HVAC design and energy program.

Roofing system manufacturers may require use of their own insulations or limit approvals to specific insulation manufacturers. Retain second option in "General" paragraph below if FM Global approval is required.

* + - * 1. General: Preformed roof insulation boards manufactured**[ or approved]** by TPO roof membrane manufacturer**[, approved for use in FM Approvals' RoofNav listed roof assemblies] [, approved for use in SPRI's Directory of Roof Assemblies listed roof assemblies]**.

Second option in "Extruded-Polystyrene Board Insulation" paragraph below is for high compressive strength insulation for use with protected membrane roof systems, plaza decks, and other installations requiring high compressive strength insulation.

* + - * 1. Extruded-Polystyrene Board Insulation: ASTM C578, **[Type IV, 1.45-lb/cu. ft. minimum density, 25 psi minimum compressive strength] [Type V, 3.00-lb/cu. ft, minimum density, 100 psi minimum compressive strength]**, square edged.

Thermal Resistance: R-value of 5.0 per 1 inch.

Adhered insulation usually requires first option in "Size" subparagraph below.

Size: **[48 by 48 inches] [48 by 96 inches]**.

Revise base-layer thickness to suit Project. Insert upper-layer insulation thickness to achieve required R-value of roof/ceiling assembly.

Thickness:

Base Layer: **[1-1/2 inches] <Insert thickness>**.

Upper Layer: **<Insert thickness>**.

Retain "Molded (Expanded) Polystyrene Board Insulation" paragraph below for noncomposite, unfaced, molded polystyrene board insulation. Product indicated is for minimum density recommended by NRCA. Revise for other densities, along with revising compressive strength and thermal resistance. For example, ASTM C578, Type II has a minimum density of 1.35 lb/cu. ft., a minimum compressive strength of 15 psi, and a thermal resistance of 4.0 per inch. EPS insulation requires a cover board for adhered and mechanically attached roof systems.

* + - * 1. Molded (Expanded) Polystyrene Board Insulation: ASTM C578, Type VIII, 1.15-lb/cu. ft. minimum density, 13-psi minimum compressive strength, square edge.

Thermal Resistance: R-value of 3.8 per 1 inch.

Adhered insulation usually requires first option in "Size" subparagraph below.

Size: **[48 by 48 inches] [48 by 96 inches]**.

Revise base-layer thickness to suit Project. Insert upper-layer insulation thickness to achieve required R-value of roof/ceiling assembly.

Thickness:

Base Layer: **[1-1/2 inches] <Insert thickness>**.

Upper Layer: **<Insert thickness>**.

Retain "Composite Molded (Expanded) Polystyrene Board Insulation" paragraph below for composite molded polystyrene board insulation.

* + - * 1. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, **[Type II, 1.35-lb/cu. ft.] [Type VIII, 1.15-lb/cu. ft.] [Type IX, 1.8-lb/cu. ft.]** minimum density, with factory-applied facings, as follows:

Verify availability of facers with manufacturers.

Facer: **[ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch thick] [DOC PS 2, Exposure 1, oriented strand board, 7/16 inch thick] <Insert material>**.

Adhered insulation usually requires first option in "Size" subparagraph below.

Size: **[48 by 48 inches] [48 by 96 inches]**.

Thickness: **<Insert thickness>**.

Retain "Polyisocyanurate Board Insulation" paragraph below for polyisocyanurate board insulation with felt or glass-fiber mat facers. Retain one of two options below; first option is suitable for all roof types; second option is for single-ply membranes using water-based bonding adhesives. For higher compressive strength insulation, revise to Grade 3. Verify availability of options with insulation manufacturers. Retain paragraph with "Composite Polyisocyanurate Board Insulation" paragraph if combining composite and noncomposite polyisocyanurate board insulation in two or more layers.

* + - * 1. Polyisocyanurate Board Insulation: ASTM C1289, **[Type II, Class 1, Grade 2] [Type II, Class 2, Grade 2]**, felt or glass-fiber mat facer on both major surfaces.

Coordinate "Compressive Strength" subparagraph below with grade of insulation retained in "Polyisocyanurate Board Insulation" paragraph above. First option is for Grade 2; second option is for Grade 3.

Compressive Strength: **[20 psi] [25 psi]**.

Adhered insulation usually requires first option in "Size" subparagraph below.

Size: **[48 by 48 inches] [48 by 96 inches]**.

Revise base-layer thickness to suit Project. Insert upper-layer insulation thickness to achieve required R-value of roof/ceiling assembly.

Thickness:

Base Layer: **[1-1/2 inches] <Insert thickness>**.

Upper Layer: **<Insert thickness>**.

Retain "Composite Polyisocyanurate Board Insulation" paragraph below for composite polyisocyanurate board insulation faced with factory-applied facing board on one side and felt or glass-fiber mat facer on the other. Verify availability of facing board types and thicknesses with composite insulation manufacturers.

* + - * 1. Composite Polyisocyanurate Board Insulation: ASTM C1289, with factory-applied facing board on one major surface, as indicated below by type, and felt or glass-fiber mat facer on the other.

Verify availability of facers with manufacturers.

Facer: **[Type IV, cellulosic-fiber-insulating-board facer, Grade 2, 1/2 inch thick] [Type V, oriented strand board facer, 7/16 inch thick] [Type VII, glass-mat-faced gypsum board facer, 1/4 inch thick] <Insert material>**.

Adhered insulation usually requires first option in "Size" subparagraph below.

Size: **[48 by 48 inches] [48 by 96 inches]**.

Thickness: **<Insert thickness>**.

* + - * 1. Perlite Board Insulation: ASTM C728, Type 1, rigid, mineral-aggregate thermal insulation board composed of expanded perlite, cellulosic fibers, binders, and waterproofing agents with top surface seal coated.

Thermal Resistance: R-value of 2.78 per 1 inch.

Adhered insulation usually requires first option in "Size" subparagraph below.

Size: **[48 by 48 inches] [48 by 96 inches]**.

Revise base-layer thickness to suit Project. Insert upper-layer insulation thickness to achieve required R-value of roof/ceiling assembly.

Thickness:

Base Layer: **[1-1/2 inches] <Insert thickness>**.

Upper Layer: **<Insert thickness>**.

* + - * 1. Cellulosic-Fiber Board Insulation: ASTM C208, Type II, Grade 2, fibrous-felted, rigid insulation boards of wood fiber or other cellulosic-fiber and water-resistant binders, asphalt impregnated, chemically treated for deterioration.

Thermal Resistance: R-value of 2.78 per 1 inch.

Adhered insulation usually requires first option in "Size" subparagraph below.

Size: **[48 by 48 inches] [48 by 96 inches]**.

Revise base-layer thickness to suit Project. Insert upper-layer insulation thickness to achieve required R-value of roof/ceiling assembly.

Thickness:

Base Layer: **[1 inch] [2 inches] <Insert thickness>**.

Upper Layer: **<Insert thickness>**.

Cellular-glass board insulation is rarely used in TPO roofing systems. Board dimensions are 24 by 48 inches.

* + - * 1. Cellular-Glass Board Insulation: ASTM C552, Type IV, rigid, cellular-glass thermal board insulation faced with manufacturer's standard kraft-paper sheets.

Thermal Resistance: R-value of 3.44 per 1 inch.

Size: 24 by 48 inches.

Thickness: **<Insert thickness>**.

Mineral wool insulation in first paragraph below cannot be tapered.

* + - * 1. Mineral Wool Insulation - Multi-Density: ASTM C726, Type I, Class 1, comprising monolithic fibrous material having an upper layer of 11.2-lb/cu. ft. density, and a lower layer of 7.5-lb/cu. ft. density.

Thermal Resistance: R-value of 3.8 per 1 inch

Size: **[48 by 48 inches] [48 by 96 inches]**.

Revise base layer thickness to suit Project. Insert upper layer insulation thickness to achieve required R-value of roof/ceiling assembly.

Thickness:

Base Layer: **[2 inches] <Insert thickness>**.

Upper Layer: **<Insert thickness>**.

Retain "Face Treatment" subparagraph below when fabric-backed roof membranes are adhered to mineral wool insulation using asphaltic materials.

Face Treatment: Bitumen coating.

* + - * 1. Mineral Wool Insulation - Single Density: ASTM C726, Type II, Class 1, comprising monolithic fibrous material having 12.5-lb/cu. ft. density.

Thermal Resistance: R-value of 4.0 per 1 inch.

Size: 48 by 48 inches.

Thickness: 1 inch.

Retain "Face Treatment" subparagraph below when fabric-backed roof membranes are adhered to mineral wool insulation using asphaltic materials.

Face Treatment: Bitumen coating.

Retain "Tapered Insulation" paragraph below if tapered insulation is required. Most of the commonly used insulations are available in tapered form; verify with manufacturers. With some exceptions, codes require roof slopes to be not less than 1/4 inch per foot (1:48). Insulation is manufactured with tapers ranging from 1/8 to 1/2 inch per foot (1:96 to 1:24).

* + - * 1. Tapered Insulation: Provide factory-tapered insulation boards.

Material: **[Match roof insulation] <Insert material>**.

Minimum Thickness: 1/4 inch.

Slope:

Roof Field: **[1/4 inch per foot] <Insert slope>** unless otherwise indicated on Drawings.

Saddles and Crickets: **[1/2 inch per foot] <Insert slope>** unless otherwise indicated on Drawings.

* + - 1. INSULATION ACCESSORIES AND COVER BOARD
				1. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

Retain "Fasteners" paragraph below if insulation requires mechanical fastening. Retain option if separate cover boards require fastening.

* + - * 1. Fasteners: Factory-coated steel fasteners with metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation **[and cover boards]** to substrate, and acceptable to roofing system manufacturer.

Retain "Induction-Welding Plates" paragraph below for induction-welding installation. Retain option to use thermal spacers over EPS or XPS to avoid melting if there is no cover board.

* + - * 1. Induction-Welding Plates: Minimum 3-inch diameter with recessed center, 0.034-inch thick, aluminum-zinc-alloy-coated steel plates, factory-coated with adhesive formulated for roof membrane, with corresponding corrosion-resistant fasteners **[and thermal isolation spacers below plates]**.
				2. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:

Retain one of first three subparagraphs below.

Modified asphaltic, asbestos-free, cold-applied adhesive.

Bead-applied, low-rise, one-component or multicomponent urethane adhesive.

Full-spread, spray-applied, low-rise, two-component urethane adhesive.

Retain one of first seven paragraphs below if cover board is required. Cover boards are usually needed over noncomposite foam insulation. See the Evaluations. Gypsum-based cover boards are not recommended when cover board temperatures are expected to reach 130 deg F (59.4 deg C) and above. Cover boards are not recommended with a ballasted system. Induction welding typically requires a cover board over EPS, XPS, and foil-faced insulation boards; and existing asphalt-based roofing.

* + - * 1. Cellulosic-Fiber Insulation Cover Board: ASTM C208, Type II, Grade 2, high-density cellulosic-fiber insulation board, having a minimum compressive strength of 40 psi.

Thickness: **[1/2 inch] [1 inch] <Insert thickness>**.

Surface finish: **[Primed one side] [Primed two sides with non-asphaltic primer] [Integral coating, six sides] [Unprimed] <Insert finish>**.

* + - * 1. Oriented Strand Board: DOC PS 2, Exposure 1, 7/16 inch thick.
				2. Glass-Mat Gypsum Cover Board: ASTM C1177, water-resistant gypsum board.

Thickness: **[1/4 inch] [1/2 inch] [5/8 inch]**.

Surface Finish: **[Fiberglass facer] [Factory primed] [Unprimed]**.

* + - * 1. Fiber-Reinforced Gypsum Roof Board: ASTM C1278, cellulosic-fiber reinforced, water-resistant gypsum board.

Thickness: **[1/4 inch] [3/8 inch] [1/2 inch] [5/8 inch]**.

* + - * 1. Fiber-Reinforced Cementitious Cover Board: ASTM C1325, fiber-mat-reinforced cementitious board.

Thickness: **[7/16 inch] [1/2 inch] [5/8 inch]**.

* + - * 1. Fiber-Reinforced Recycled Plastic Cover Board: Cellulose fiber blended with recycled plastic board.

Thickness: **[1/4 inch] [1/2 inch]**.

Surface Finish: **[Fiberglass facer] [Paper facer]**.

* + - * 1. Polyisocyanurate Insulation Cover Board: ASTM C1289 Type II, Class 4, Grade 1, 1/2 inch (13 mm) thick, with a minimum compressive strength of 80 psi.

Protection mats in "Protection Mat" paragraph below may be placed on roof membrane as protection from roof pavers or crushed-aggregate ballast.

* + - * 1. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric; water permeable and resistant to UV degradation; type and weight as recommended by roofing system manufacturer for application.
			1. ASPHALT MATERIALS

Retain this article if adhering fabric-backed roof membranes or roof insulation or if creating a built-up vapor retarder from felts and hot asphalt. However, usually delete this article for sustainable projects. Verify with applicable sustainable program.

* + - * 1. Roofing Asphalt: **[ASTM D312, Type III or Type IV] [ASTM D6152, SEBS modified]**.

Retain "Asphalt Primer" paragraph below if priming concrete roof deck.

* + - * 1. Asphalt Primer: ASTM D41.
			1. ELECTRONIC LEAK DETECTION (ELD) MATERIALS

Retain this article if required for ELD testing. Certain roof assembly components including dry insulation and cover boards require a conductive medium installed immediately below the roof membrane. Confirm selected materials will not void roofing warranty. See the Evaluations.

* + - * 1. Conductive Medium: Materials providing less than 104 ohms per square as determined in accordance with ASTM D4496 and approved by roof membrane manufacturer.

Electrically Conductive Primer: Water-based, non-flammable, nonmetallic, low-VOC primer[, **UL listed and FM Global approved]**.

Grounding Screen: **[Welded, stainless steel mesh] [Aluminum screen]**, for use with vector mapping system **[, FM Global approved]**.

Electrically Conductive Fabric: Non-abrasive felt.

* + - * 1. Leak Detection and Moisture-Monitoring System: Permanent, embedded leak detection and moisture-monitoring system.

Sensors measuring moisture content[, temperature, and vapor drive], placed [below roof insulation] [over vapor barrier] and connected to a monitoring program, with a notification indicating location of breach.

Sensors measuring moisture content[, temperature, and vapor drive], in a conductive fabric placed below roof membrane and connected to a monitoring program, with a notification indicating location of breach.

* + - 1. BALLAST

Retain this article for loosely laid and ballasted installations.

Retain "Aggregate Ballast" paragraph below for aggregate-ballasted installations. If smooth-faced aggregate is preferred, verify availability and cost. Roof membranes in contact with sharper crushed aggregate needs added protection to prevent puncturing. Insert requirements for color if required.

* + - * 1. Aggregate Ballast: **[Smooth, washed, riverbed gravel or other acceptable smooth-faced stone] [Crushed gravel or crushed stone]** that withstands weather exposure without significant deterioration and does not contribute to membrane degradation, of the following size:

Retain one or more of three options in "Size" subparagraph below to suit Project. Second option is based on recommendations in FM Global Property Loss Prevention Data Sheet 1-29.

Size: ASTM D448, **[Size 2, ranging in size from 1-1/2 to 2-1/2 inches] [ASTM D448, Size 3, ranging in size from 1 to 2 inches] [Size 4, ranging in size from 3/4 to 1-1/2 inches] <Insert size>**.

Pavers may be used alone or with aggregate ballast for functional or decorative purposes.

* + - * 1. Lightweight Roof Pavers: Interlocking, lightweight concrete units; grooved back, with four-way drainage capability; beveled, doweled, or otherwise profiled; and as follows:

Coordinate size selection in "Size" subparagraph below with minimum paver coverage required, especially at corners, perimeter, penetrations, and above large wall openings. Paver sizes vary among manufacturers and include 8 by 16, 12 by 12, 12 by 16-1/2, and 12 by 18 inches.

Size: **<Insert actual size of pavers>**.

Insert weight of roof paver in "Weight" subparagraph below. SPRI identifies interlocking, lightweight roof pavers as weighing at least 10 lb/sq. ft, but not exceeding 18 lb/sq. ft. Verify availability with manufacturers.

Weight: **<Insert weight or weight range>**.

Retain one of two options in "Compressive Strength" subparagraph below.

Compressive Strength: **[2500 psi] [5000 psi] <Insert value>**, minimum.

Retain one of three options in "Colors and Textures" subparagraph below. If retaining first option, indicate colors and textures in a separate schedule.

Colors and Textures: **[As indicated by manufacturer's designations] [Match Director’s Representative’s samples] [As selected by Director’s Representative from manufacturer's full range]**.

* + - * 1. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed concrete units, **[square edged] [with top edges beveled 3/16 inch]**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

Coordinate size selection in "Size" subparagraph below with minimum paver coverage required, especially at corners, perimeter, penetrations, and above large wall openings. Consider handling of pavers as weight increases. Paver sizes vary among manufacturers and include 12 by 12 and 18 by 18 inches.

Size: **[24 by 24 inches] <Insert dimensions>**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch in length, height, and thickness.

Retain one of two options in "Weight" subparagraph below. ANSI/SPRI RP-4 allows roof pavers weighing 18 lb/sq. ft. for System 1 at all locations and for System 2 at field of roof. Pavers weighing 22 lb/sq. ft. are required for System 2 corner and perimeter areas and all areas for System 3. Verify availability with manufacturers, and coordinate with size of paver in "Size" subparagraph above if weight of paver unit is a consideration.

Weight: **[18 lb/sq. ft.] [22 lb/sq. ft.] <Insert value>**.

Retain one of two options in "Compressive Strength" below.

Compressive Strength: **[7500 psi ] [6500 psi ] <Insert value>**, minimum.

Retain one of three options in "Colors and Textures" subparagraph below. If retaining first option, indicate colors and textures in a separate schedule.

Colors and Textures: **[As indicated by manufacturer's designations] [Match Director’s Representative’s samples] [As selected by Director’s Representative’s from manufacturer's full range]**.

* + - 1. WALKWAYS

Retain "Flexible Walkways" or "Walkway Roof Pavers" paragraph below for preformed roof walkway products. Revise to suit other walkway products if required.

* + - * 1. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway **[pads] [or] [rolls]**, approximately 3/16 inch thick and acceptable to roofing system manufacturer.

Size: Approximately36 by 60 inches.

Color: Contrasting with roof membrane.

Retain "Walkway Roof Pavers" paragraph below if using heavyweight roof pavers as walkways.

* + - * 1. Walkway Roof Pavers: Heavyweight, hydraulically pressed concrete units, **[square edged] [with top edges beveled 3/16 inch]**, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

Coordinate size selection in "Size" subparagraph below with minimum paver coverage required, especially at corners, perimeter, penetrations, and above large wall openings. Consider handling of pavers as weight increases. Paver sizes vary among manufacturers and include 12 by 12 and 18 by 18 inches.

Size: **[24 by 24 inches] <Insert dimensions>**. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch in length, height, and thickness.

Retain one of two options in "Weight" subparagraph below. ANSI/SPRI RP-4 allows roof pavers weighing 18 lb/sq. ft for System 1 at all locations and for System 2 at field of roof. Pavers weighing 22 lb/sq. ft. are required for System 2 corner and perimeter areas and all areas for System 3. Verify availability with manufacturers, and coordinate with size of paver in "Size" subparagraph above if weight of paver unit is a consideration.

Weight: **[18 lb/sq. ft.] [22 lb/sq. ft.] <Insert value>**.

Retain one of two options in "Compressive Strength" subparagraph below.

Compressive Strength: **[7500 psi] [6500 psi] <Insert value>**, minimum.

Retain one of three options in "Colors and Textures" subparagraph below. If retaining first option, indicate colors and textures in a separate schedule.

Colors and Textures: **[As indicated by manufacturer's designations] [Match Director’s Representative’s samples] [As selected by Director’s Representative from manufacturer's full range]**.

1. EXECUTION
	* + 1. EXAMINATION
				1. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.

Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

Retain first subparagraph below for steel roof deck.

Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."

Retain or revise subparagraphs below for concrete roof decks.

Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.

Verify that concrete substrate is visibly dry and free of moisture, and that minimum concrete internal relative humidity is not more than **[75] <Insert number>** percent, or as recommended by roofing system manufacturer, when tested according to ASTM F2170.

Test Frequency: One test probe per each **[1000 sq. ft.] <Insert area>**, or portion thereof, of roof deck, with not less than three tests probes.

Submit test reports within 24 hours after performing tests.

Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.

Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.

Retain first subparagraph below for lightweight insulating concrete roof decks.

Verify that minimum curing period recommended by roofing system manufacturer for lightweight insulating concrete roof decks has passed.

Retain both subparagraphs below for cementitious wood-fiber roof decks.

Verify any damaged sections of cementitious wood-fiber decks have been repaired or replaced.

Verify adjacent cementitious wood-fiber panels are vertically aligned to within 1/8 inch at top surface.

* + - * 1. Proceed with installation only after unsatisfactory conditions have been corrected.
			1. PREPARATION
				1. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.
				2. 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.

Retain first paragraph below for lightweight insulating concrete roof decks, wood and wood panel roof decks, poured gypsum roof decks, cementitious wood-fiber plank roof decks, and steel roof decks less than 0.295 inch thick.

* + - * 1. Perform fastener-pullout tests according to roof system manufacturer's written instructions.

Submit test result within 24 hours after performing tests.

Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

Retain paragraph below if acoustical roof deck rib insulation, shaped to fit into topside ribs of acoustical roof deck, is installed in this Section.

* + - * 1. Install sound-absorbing insulation strips according to acoustical roof deck manufacturer's written instructions.
			1. INSTALLATION OF ROOFING, GENERAL

First option in first paragraph below applies only to concrete, lightweight insulating concrete, and steel roof decks. Second option applies to concrete, lightweight insulating concrete, cementitious wood fiber, steel, and wood roof decks. See the Evaluations.

* + - * 1. Install roofing system according to roofing system manufacturer's written instructions, **[FM Approvals' RoofNav] [SPRI's Directory of Roof Assemblies]** listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
				2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning Work on adjoining roofing.

Retain first paragraph below if tie-ins to existing roofing are required.

* + - * 1. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition **[ and to not void warranty for existing roofing system]**.

Retain paragraph below when air barriers are part of Project. Drawing details should specifically illustrate transition between different air barrier components.

* + - * 1. Coordinate installation and transition of roofing system component serving as an air barrier with air barrier specified under **[Section 072713 "Modified Bituminous Sheet Air Barriers."] [Section 072715 "Nonbituminous Self-Adhering Sheet Air Barriers."] [Section 072726 "Fluid-Applied Membrane Air Barriers."]**
			1. INSTALLATION OF SUBSTRATE BOARD
				1. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.

Retain first subparagraph below for steel roof decks.

At steel roof decks, install substrate board at right angle to flutes of deck.

Locate end joints over crests of steel roof deck.

Tightly butt substrate boards together.

Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Retain one of first two subparagraphs below if mechanical fastening of substrate board to steel roof deck is required. Substrate board is usually attached when base layer of roof insulation, which overlays substrate board, is attached.

Fasten substrate board to top flanges of steel deck according to recommendations in **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29.

Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

Retain subparagraph below for loosely laid and ballasted roofing systems, and for roofing systems not including a vapor retarder but incorporating the first layer of insulation over the substrate board to be mechanically attached to the roof deck.

Loosely lay substrate board over roof deck.

* + - 1. INSTALLATION OF VAPOR RETARDER

Retain applicable vapor retarder material in this article. Verify, with roof membrane manufacturer, if a vapor retarder is required over lightweight structural concrete roof decks, normal weight concrete roof decks, or under any other circumstances. Coordinate vapor retarder material and installation method with wind uplift requirements. Retain material and installation method to minimize penetrations through vapor retarder. Retitle article "Air Barrier Installation" if that is primary function; revise installation requirements if necessary.

* + - * 1. 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 2 and 6 inches, respectively.

Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.

Continuously seal side and end laps with **[tape] [adhesive]**.

* + - * 1. Laminate Sheet: Loosely lay laminate-sheet vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 and 6 inches, respectively.

Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.

Continuously seal side and end laps with tape.

* + - * 1. Self-Adhering-Sheet Vapor Retarder: Prime substrate if required by manufacturer. Install self-adhering-sheet vapor retarder over area to receive vapor retarder, side and end lapping each sheet a minimum of 3-1/2 and 6 inches, respectively.

Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.

Seal laps by rolling.

Usually delete "Built-Up Vapor Retarder" paragraph below for sustainable projects. Verify with applicable sustainable program.

* + - * 1. Built-Up Vapor Retarder: Install two glass-fiber felt plies lapping each felt 19 inches over preceding felt.

Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.

Embed each felt in a solid mopping of hot roofing asphalt.

Glaze coat completed surface with hot roofing asphalt.

Apply hot roofing asphalt within plus or minus 25 deg F of equiviscous temperature.

Always retain paragraph below. To function effectively, vapor retarders or air barriers must prevent air movement into roofing system.

* + - * 1. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.
			1. INSTALLATION OF INSULATION
				1. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
				2. Comply with roofing system and roof insulation manufacturer's written instructions for installing roof insulation.
				3. Installation Over Metal Decking:

In first subparagraph below, retain first option for 48-by-48-inch insulation boards. Retain second option for 48-by-96-inch insulation boards. Retain third option with second option when insulation is installed directly over metal roof decks.

Install base layer of insulation with **[joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows] [ and with long joints continuous at right angle to flutes of decking]**.

Retain first subparagraph below when insulation is installed directly over metal decking.

Locate end joints over crests of decking.

Retain first subparagraph below when a composite top layer is required over one or more layers of noncomposite molded (expanded) polystyrene or polyisocyanurate board insulation.

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.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay base layer of insulation units over substrate.

Retain first subparagraph below if base layer is mechanically attached, or if corner and perimeter insulation is attached beneath loosely laid and aggregate-ballasted roof systems.

Mechanically attach base layer of insulation **[ and substrate board]** using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.

Retain first subparagraph below if Project is FM Global insured, or if FM Global or SPRI Directory of Roof Assemblies requirements are proposed as a performance standard. Retain second subparagraph if fastening is based on "Wind Uplift Resistance" paragraph in "Performance Requirements" Article. Coordinate with "Performance Requirements" Article. Fastener numbers will increase at corners and perimeter over number required for field of roof.

Fasten insulation according to requirements in [FM Approvals' RoofNav for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity].

Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

Retain option in first subparagraph below if tapered insulation is applicable.

Install upper layers of insulation**[ and tapered insulation]** with joints of each layer offset not less than 12 inches from previous layer of insulation.

Retain first subparagraph below for 48-by-48-inch insulation boards.

Staggered end joints within each layer not less than 24 inches in adjacent rows.

Retain first subparagraph below and delete last subparagraph above for 48-by-96-inch insulation boards.

Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay each layer of insulation units over substrate.

Retain first subparagraph below with mechanically attached base layer insulation.

Adhere each layer of insulation to substrate using adhesive according to **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain first subparagraph below for hot-asphalt application. Usually delete for sustainable projects. Verify with applicable sustainable program.

Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of two subparagraphs below and delete last subparagraph above for low-rise urethane adhesive application. Coordinate with product selected.

Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

* + - * 1. Installation Over **[Wood] [Wood Panel]** Decking:

A mechanically fastened slip sheet is required when an adhesive or hot asphalt is used as a means of attaching roof insulation. Verify with manufacturer for other conditions requiring use of a slip sheet over wood or wood panel decking.

Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to **[wood] [wood panel]** decks.

Retain first subparagraph below if SPRI Directory of Roof Assemblies requirements are proposed as a performance standard. Retain second subparagraph if fastening is based on "Wind Uplift Resistance" paragraph in "Performance Requirements" Article. Coordinate with "Performance Requirements" Article. Fastener numbers will increase at corners and perimeter over number required for field of roof.

Fasten slip sheet according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.

Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

In first subparagraph below, retain first option for 48-by-48-inch insulation boards; second option for 48-by-96-inch insulation boards.

Install base layer of insulation with **[joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows]**.

Retain first subparagraph below when a composite top layer is required over one or more layers of noncomposite molded (expanded) polystyrene or polyisocyanurate board insulation.

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.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay base layer of insulation units over substrate.

Retain first subparagraph below if base layer is mechanically attached, or if corner and perimeter insulation is attached beneath loosely laid and aggregate-ballasted roofing systems.

Mechanically attach base layer of insulation**[ and substrate board]** using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to **[wood] [wood panel]** decks.

Retain first subparagraph below if SPRI Directory of Roof Assemblies requirements are proposed as a performance standard. Retain second subparagraph if fastening is based on "Wind Uplift Resistance" paragraph in "Performance Requirements" Article. Coordinate with "Performance Requirements" Article. Fastener numbers will increase at corners and perimeter over number required for field of roof.

Fasten insulation according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.

Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.

Retain option in first subparagraph below if tapered insulation is applicable.

Install upper layers of insulation**[ and tapered insulation]** with joints of each layer offset not less than 12 inches from previous layer of insulation.

Retain first subparagraph below for 48-by-48-inch insulation boards.

Staggered end joints within each layer not less than 24 inches in adjacent rows.

Retain first subparagraph below and delete last subparagraph above for 48-by-96-inch insulation boards.

Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay each layer of insulation units over substrate.

Retain first subparagraph below with mechanically attached base layer insulation.

Adhere each layer of insulation to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain first subparagraph below for hot-asphalt application. Usually delete for sustainable projects. Verify with applicable sustainable program.

Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of two subparagraphs below and delete last subparagraph above for low-rise urethane adhesive application. Coordinate with product selected.

Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

* + - * 1. Installation Over Concrete Decks:

In first subparagraph below, retain first option for 48-by-48-inch insulation boards; second option for 48-by-96-inch insulation boards.

Install base layer of insulation with **[joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows]**.

Retain first subparagraph below when a composite top layer is required over one or more layers of noncomposite molded (expanded) polystyrene or polyisocyanurate board insulation.

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.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay base layer of insulation units over substrate.

Retain first subparagraph below if base layer of insulation is adhered to roof deck or to vapor retarder, or if corner and perimeter insulation is attached beneath loosely laid aggregate-ballasted roofing systems.

Adhere base layer of insulation to **[concrete roof deck] [vapor retarder]** according to **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain one or both of first two subparagraphs below for hot-asphalt application. Retain both subparagraphs for application directly over concrete roof decks. Retain only second subparagraph for applications over vapor retarder. Usually delete for sustainable projects. Verify with applicable sustainable program.

Prime surface of concrete deck with asphalt primer at rate of 3/4 gal./100 sq. ft., and allow primer to dry.

Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of first two subparagraphs below and delete last subparagraphs above for low-rise urethane adhesive application. Coordinate with product selected.

Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

Retain option in first subparagraph below if tapered insulation is applicable.

Install upper layers of insulation**[ and tapered insulation]** with joints of each layer offset not less than 12 inches from previous layer of insulation.

Retain first subparagraph below for 48-by-48-inch insulation boards.

Staggered end joints within each layer not less than 24 inches in adjacent rows.

Retain first subparagraph below and delete last subparagraph above for 48-by-96-inch insulation boards.

Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay each layer of insulation units over substrate.

Retain first subparagraph below with adhered base layer insulation.

Adhere each layer of insulation to substrate using adhesive according to **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain first subparagraph below for hot-asphalt application. Usually delete for sustainable projects. Verify with applicable sustainable program.

Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of two subparagraphs below and delete last subparagraph above for low-rise urethane adhesive application. Coordinate with product selected.

Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

* + - * 1. Installation Over Cementitious Wood Fiber Decks:

Retain first subparagraph below if a slip sheet is required. NRCA recommends a mechanically fastened slip sheet over cementitious wood-fiber roof decks. However, some roof membrane manufacturers allow insulation to be directly attached to the cementitious wood-fiber roof deck of not less than 2 inches (51 mm) in thickness with either mechanical fasteners or cold adhesive. The use of hot asphalt as a means of attaching roof insulation requires a slip sheet over cementitious wood-fiber roof decks.

Mechanically fasten slip sheet to roof deck using mechanical fasteners specifically designed and sized for fastening slip sheet to cementitious wood-fiber decks.

Retain first subparagraph below if SPRI's Directory of Roof Assemblies requirements are proposed as a performance standard. Retain second subparagraph if fastening is based on "Wind Uplift Resistance" paragraph in "Performance Requirements" Article. Coordinate with "Performance Requirements" Article. Fastener numbers will increase at corners and perimeter over number required for field of roof.

Fasten slip sheet according to requirements in SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity.

Fasten slip sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

In first subparagraph below, retain first option for 48-by-48-inch insulation boards; second option for 48-by-96-inch insulation boards.

Install base layer of insulation with **[joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows]**.

Retain first subparagraph below when a composite top layer is required over one or more layers of noncomposite molded (expanded) polystyrene or polyisocyanurate board insulation.

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.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay base layer of insulation units over substrate.

Retain first subparagraph below if base layer of insulation is adhered to slip sheet, or if corner and perimeter insulation is attached beneath loosely laid aggregate-ballasted roofing systems.

Adhere base layer of insulation to slip sheet according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain first subparagraph below for hot-asphalt application. Usually delete for sustainable projects. Verify with applicable sustainable program.

Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of first two subparagraphs below and delete last subparagraph above for low-rise urethane adhesive application. Coordinate with product selected.

Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

Retain option in first subparagraph below if tapered insulation is applicable.

Install upper layers of insulation**[ and tapered insulation]** with joints of each layer offset not less than 12 inches from previous layer of insulation.

Retain first subparagraph below for 48-by-48-inch insulation boards.

Staggered end joints within each layer not less than 24 inches in adjacent rows.

Retain first subparagraph below and delete last subparagraph above for 48-by-96-inch insulation boards.

Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay each layer of insulation units over substrate.

Retain first subparagraph below with adhered base layer insulation.

Adhere each layer of insulation to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain first subparagraph below for hot-asphalt application. Usually delete for sustainable projects. Verify with applicable sustainable program.

Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of two subparagraphs below and delete last subparagraph above for low-rise urethane adhesive application. Coordinate with product selected.

Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

* + - * 1. Installation Over Lightweight Insulating Concrete Decks:

Mechanically fasten vented base sheet to lightweight insulating concrete, with vented side down, using mechanical fasteners specifically designed and sized for fastening to lightweight insulating concrete decks.

Retain first subparagraph below if Project is FM Global insured, or if FM Global or SPRI Directory of Roof Assemblies requirements are proposed as a performance standard. Retain second subparagraph if fastening is based on "Wind Uplift Resistance" paragraph in "Performance Requirements" Article. Coordinate with "Performance Requirements" Article. Fastener numbers will increase at corners and perimeter over number required for field of roof.

Fasten vented base sheet according to requirements in [FM Approvals' RoofNav for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies for specified Wind Uplift Load Capacity].

Fasten vented base sheet to resist specified uplift pressure at corners, perimeter, and field of roof.

Retain board insulation layers from subparagraphs below if additional insulation is required over lightweight insulating concrete.

In first subparagraph below, retain first option for 48-by-48-inch insulation board; second option for 48-by-96-inch insulation boards.

Install base layer of insulation with **[joints staggered not less than 24 inches in adjacent rows] [end joints staggered not less than 12 inches in adjacent rows]**.

Retain first subparagraph below when a composite top layer is required over one or more layers of noncomposite molded (expanded) polystyrene or polyisocyanurate board insulation.

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.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay base layer of insulation units over substrate.

Retain first subparagraph below if base layer of insulation is adhered to vented base sheet, or if corner and perimeter insulation is attached beneath loosely laid aggregate-ballasted roofing systems.

Adhere base layer of insulation to vented base sheet according to **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain first subparagraph below for hot-asphalt application. Usually delete for sustainable projects. Verify with applicable sustainable program.

Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of first two subparagraphs below and delete last subparagraph above for low-rise urethane adhesive application. Coordinate with product selected.

Set insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

Retain option in first subparagraph below if tapered insulation is applicable.

Install upper layers of insulation**[ and tapered insulation]** with joints of each layer offset not less than 12 inches from previous layer of insulation.

Retain first subparagraph below for 48-by-48-inch insulation boards.

Staggered end joints within each layer not less than 24 inches in adjacent rows.

Retain first subparagraph below and delete last subparagraph above for 48-by-96-inch insulation boards.

Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.

Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

Make joints between adjacent insulation boards not more than 1/4 inch in width.

At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.

Trim insulation so that water flow is unrestricted.

Fill gaps exceeding 1/4 inch with insulation.

Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.

Retain first subparagraph below for induction-welded systems or loosely laid and ballasted systems.

Loosely lay each layer of insulation units over substrate.

Retain first subparagraph below with adhered base layer insulation.

Adhere each layer of insulation to substrate using adhesive according to **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain first subparagraph below for hot-asphalt application. Usually delete for sustainable projects. Verify with applicable sustainable program.

Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of two subparagraphs below and delete last subparagraph above for low-rise urethane adhesive application. Coordinate with product selected.

Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

Retain paragraph below in addition to others above for induction-welded systems when no cover board is used.

* + - * 1. Place**[ thermal spacers and]** plates on insulation in required fastening patterns**[ to achieve FM rating]** and secure in accordance with manufacturer’s instructions.

Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending 1 inch minimum into roof deck; do not overdrive fasteners.

* + - 1. INSTALLATION OF COVER BOARDS

For reroofing applications where a portion of the existing roofing system remains (re-covering), retitle article "Installation of Recovery Board" and revise words "cover board" to "recovery board" in paragraphs and subparagraphs below. Revise associated text accordingly.

Retain first paragraph below if cover boards will be field installed over roof insulation and immediately below roof membrane. Cover boards are not recommended with a ballasted system.

* + - * 1. 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 in each direction.

Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.

At internal roof drains, conform to slope of drain sump.

Trim cover board so that water flow is unrestricted.

Cut and fit cover board tight to nailers, projections, and penetrations.

Retain first subparagraph below for loosely laid and ballasted roofing systems. Consult roof membrane manufacturer.

Loosely lay cover board over substrate.

Retain first subparagraph below with adhered insulation. First option below applies only to concrete, lightweight insulating concrete, and steel roof decks. Second option applies to concrete, lightweight insulating concrete, cementitious wood fiber, steel, and wood roof decks. See the Evaluations.

Adhere cover board to substrate using adhesive according to **[FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification] [SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity]** and FM Global Property Loss Prevention Data Sheet 1-29, as follows:

Retain first subparagraph below for hot-asphalt application. Usually delete for sustainable projects. Verify with applicable sustainable program.

Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.

Retain one of two subparagraphs below and delete last subparagraph above for low-rise urethane adhesive application. Coordinate with product selected.

Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.

Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

Retain paragraph below if slip sheet is required over cover board.

* + - * 1. Install slip sheet over cover board and beneath roof membrane.

Retain paragraph below for induction-welded systems.

* + - * 1. Place plates on insulation in required fastening patterns**[ to achieve FM rating]** and secure in accordance with manufacturer’s instructions.

Install plates and fasteners tight and flat to substrate with no dimpling, and with fastener extending 1 inch minimum into roof deck; do not overdrive fasteners.

* + - 1. INSTALLATION OF ELD COMPONENTS

Retain first paragraph below if conductive medium will be field installed immediately below roof membrane.

* + - * 1. Install conductive medium over **[cover board] [insulation] [and on vertical locations to receive roof membrane]** in accordance with manufacturer's written instructions.

Retain paragraph below for embedded ELD and moisture-monitoring systems.

* + - * 1. Install sensors, **[wire loop] [conductive fabric]**, connections, and accessory items required for complete system in accordance with manufacturer's written instructions.
			1. INSTALLATION OF ADHERED ROOF MEMBRANE
				1. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
				2. Unroll roof membrane and allow to relax before installing.

Retain first paragraph below if applicable.

* + - * 1. Start installation of roofing in presence of roofing system manufacturer's technical personnel**[ and Director’s Representative’s testing and inspection agency]**.
				2. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

Retain "Bonding Adhesive" paragraph below for adhesive bonding roof membrane to substrate.

* + - * 1. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.

Retain "Hot Roofing Asphalt" or "Fabric-Backed Roof Membrane Adhesive" paragraph below for adhering fabric-backed roof membranes to substrate. Usually delete hot asphalt installation method for sustainable projects. Verify with applicable sustainable program.

* + - * 1. Hot Roofing Asphalt: Apply a solid mopping of hot roofing asphalt to substrate at temperature and rate required by manufacturer, and install fabric-backed roof membrane. Do not apply to splice area of roof membrane.
				2. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer, and install fabric-backed roof membrane.
				3. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
				4. Apply roof membrane with side laps shingled with slope of roof deck where possible.
				5. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.

Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.

Revise number of seam tests in first subparagraph below to suit Project.

Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

* + - * 1. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.
			1. INSTALLATION OF SELF-ADHERING ROOF MEMBRANE
				1. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
				2. Unroll roof membrane and allow to relax before installing.

Retain first paragraph below if applicable.

* + - * 1. Start installation of roofing in presence of roofing system manufacturer's technical personnel**[ and Director’s Representative’s testing and inspection agency]**.
				2. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer.

Stagger end laps.

* + - * 1. Fold roof membrane to expose half of sheet width's bottom surface.

Remove release liner on exposed half of sheet.

Roll roof membrane over substrate while avoiding wrinkles.

* + - * 1. Fold remaining half of roof membrane to expose bottom surface.

Remove release liner on exposed half of sheet.

Roll roof membrane over substrate while avoiding wrinkles.

* + - * 1. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
				2. Apply roof membrane with side laps shingled with slope of roof deck where possible.
				3. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings, to ensure a watertight seam installation.

Test lap edges with probe to verify seam weld continuity.

Apply lap sealant to seal cut edges of roof membrane and flashing sheet.

Revise number of seam tests in first subparagraph below to suit Project.

Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

* + - * 1. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.
			1. INSTALLATION OF MECHANICALLY FASTENED ROOF MEMBRANE

NRCA does not recommend a seam-fastened mechanically fastened roof systems over cementitious wood-fiber roof decks or lightweight insulating concrete roof decks.

* + - * 1. Mechanically fasten roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
				2. Unroll roof membrane and allow to relax before installing.

Retain first paragraph below for installations where steel roof deck is the structural substrate and wide roof membrane sheets may be used. Consider limiting roof membrane sheet width after reviewing manufacturers' criteria used to establish fastener patterns. See the Evaluations.

* + - * 1. For in-splice attachment, install roof membrane with long dimension perpendicular to steel roof deck flutes.

Retain first paragraph below if applicable.

* + - * 1. Start installation of roofing in presence of roofing system manufacturer's technical personnel **[ and Director’s Representative’s testing and inspection agency]**.
				2. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
				3. Mechanically fasten or adhere roof membrane securely at terminations, penetrations, and perimeter of roofing.
				4. Apply roof membrane with side laps shingled with slope of roof deck where possible.

Coordinate installation method with manufacturer and revise if required. "In-Seam Attachment" paragraph below follows SPRI classification for concealed fastenings within seams of a sheet.

* + - * 1. In-Seam Attachment: Secure one edge of TPO sheet using fastening plates or metal battens centered within seam, and mechanically fasten TPO sheet to roof deck.
				2. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.

Revise number of seam tests in first subparagraph below to suit Project.

Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

* + - * 1. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.
			1. INSTALLATION OF INDUCTION-WELDED ROOF MEMBRANE
				1. Unroll roof membrane and allow to relax before installing.

Retain first paragraph below if applicable.

* + - * 1. Start installation of roofing in presence of roofing system manufacturer's technical personnel **[ and Director’s Representative's testing and inspection agency]**.
				2. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer, with side laps shingled with slope of roof deck where possible.
				3. Seams: Clean seam areas, overlap roof membrane, and hot-air-weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

Test lap edges with probe to verify seam weld continuity.

Apply lap sealant to seal cut edges of roof membrane and sheet flashings.

Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

* + - * 1. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.
				2. Induction-weld roof membrane to plates in accordance with roofing system manufacturer's written instructions, creating 100 percent bond between underside of membrane and top of plates; a partial bond is unacceptable.

Test welds to verify adhesion of roof membrane to top of plates in accordance with membrane manufacturer’s instructions.

* + - 1. INSTALLATION OF LOOSELY LAID AND BALLASTED ROOF MEMBRANE
				1. Loosely lay roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
				2. Unroll roof membrane and allow to relax before installing.
				3. Comply with requirements in ANSI/SPRI RP-4 for **[System 1] [System 2] [System 3]**.

Retain first paragraph below if applicable.

* + - * 1. Start installation of roofing in presence of roofing system manufacturer's technical personnel**[ and Director’s Representative’s testing and inspection agency]**.
				2. Accurately align roof membrane, without stretching, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

Retain one of first two paragraphs below. Retain first for perimeter attachment to comply with requirements in ANSI/SPRI RP-4 for Systems 1 and 2. Retain second to comply with requirements in ANSI/SPRI RP-4 for System 3; retain "adhere" option and delete "Mechanically fasten" option when protecting the roof membrane with pavers.

* + - * 1. Mechanically fasten or adhere perimeter of roof membrane according to requirements in ANSI/SPRI RP-4.
				2. **[Mechanically fasten] [or] [adhere]** roof membrane at corners, perimeters, and transitions according to requirements in ANSI/SPRI RP-4.

Retain first subparagraph below if no protective covering of roof membrane is required at corners and perimeters. Retain second subparagraph if using heavyweight roof pavers for protection at these locations.

At corners and perimeters, omit aggregate ballast leaving roof membrane exposed.

At corners and perimeters, adhere a second layer of roof membrane.

* + - * 1. Apply roof membrane with side laps shingled with slope of deck where possible.
				2. Seams: Clean seam areas, overlap roof membrane, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.

Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and flashing sheet.

Revise number of seam tests in first subparagraph below to suit Project.

Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

* + - * 1. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

Retain first paragraph below under pavers or if crushed stone or a more angular ballast must be used. Consult roof membrane manufacturers for recommendations, because one or more layers of protection mat may be required. Revise paragraph to suit Project.

* + - * 1. Install protection mat over roof membrane, overlapping a minimum of 6 inches. Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches.

Retain "Aggregate Ballast" paragraph below if using aggregate ballast.

* + - * 1. Aggregate Ballast: Apply uniformly over roof membrane at the rate required by roofing system manufacturer, but not less than the following, spreading with care to minimize possibility of damage to roofing system. Lay ballast as roof membrane is installed, leaving roof membrane ballasted at end of workday.

Ballast Weight:

First three subparagraphs below are based on ANSI/SPRI RP-4. First corresponds to System 1, second to System 2, and third to System 2 in windborne debris areas. Revise ballast weight if more is required to fully conceal membrane.

Size 4 aggregate, 10 lb/sq. ft.

Size 2 aggregate, 13 lb/sq. ft., at corners and perimeter; Size 4 aggregate, 10 lb/sq. ft., elsewhere.

Size 2 aggregate, 13 lb/sq. ft..

Retain subparagraph below if FM Global recommendations apply. Insert weight of aggregate for each part of roof, based on recommendations in FM Global Property Loss Prevention Data Sheet 1-29. Indicate dimensions of corners, perimeter, and field of roof on Drawings, based on FM Global requirements.

Size 3 aggregate, **<Insert weight>**, at corners, **<Insert weight>** at perimeter, and **<Insert weight>**, elsewhere.

Retain "Roof-Paver Ballast" or "Roof-Paver and Aggregate Ballast" paragraph below if roof pavers are required.

* + - * 1. Roof-Paver Ballast: Install **[lightweight] [heavyweight]** roof-paver ballast according to manufacturer's written instructions.
				2. Roof-Paver and Aggregate Ballast: Install heavyweight roof pavers according to manufacturer's written instructions on roof corners and perimeter.

Retain one of two subparagraphs below if combining roof-paver and aggregate ballast based on ANSI/SPRI RP-4. First is for System 2; second is for System 2 in windborne debris areas and for System 3.

Install Size 4 aggregate ballast elsewhere on roof membrane at a minimum rate of 10 lb/sq. ft.

Install Size 2 aggregate ballast elsewhere on roof membrane at a minimum rate of 13 lb/sq. ft.

* + - 1. INSTALLATION OF BASE FLASHING
				1. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
				2. 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.
				3. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
				4. 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.
				5. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.
			2. INSTALLATION OF WALKWAYS

Retain this article if walkways are required.

* + - * 1. Flexible Walkways:

Install flexible walkways at the following locations:

Retain one or more subparagraphs below. Revise to suit Project.

Perimeter of each rooftop unit.

Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.

Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.

Top and bottom of each roof access ladder.

Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.

Locations indicated on Drawings.

As required by roof membrane manufacturer's warranty requirements.

Provide 6-inch clearance between adjoining pads.

Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

* + - * 1. Roof-Paver Walkways: Install walkway roof pavers according to manufacturer's written instructions.

Install roof paver walkways at the following locations:

Retain one or more subparagraphs below. Revise to suit Project.

Perimeter of each rooftop unit.

Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.

Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.

Top and bottom of each roof access ladder.

Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.

Locations indicated on Drawings.

As required by roof membrane manufacturer's warranty requirements.

Provide 3 inches of space between adjacent roof pavers.

* + - 1. FIELD QUALITY CONTROL

Retain this article if field inspecting and testing are required. Revise to suit local practices and requirements of authorities having jurisdiction if applicable.

Retain "Testing Agency" paragraph below to identify who will perform tests and inspections.

* + - * 1. Testing Agency: Engage a qualified testing agency to perform tests and to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Director’s Representative.
				2. Perform the following tests:

Retain one or more of "Flood Testing," "Infrared Thermography," "Electrical Capacitance/Impedance Testing," "Nuclear Hydrogen Detection Testing," "Low-Voltage ELD Testing," and "High-Voltage Membrane Testing" subparagraphs below. For more information on test procedures, see the Evaluations.

Retain "Flood Testing" subparagraph below if required. Localize testing to flashings or penetrations if preferred. Limit water depth to not more than load capacity of deck as determined by structural engineer. Review procedures in ASTM D5957 for applicability. Note that NRCA does not recommend flood testing.

Flood Testing: Flood test each roof area for leaks, according to recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.

Perform tests before overlying construction is placed.

Flood to an average depth of **[2-1/2 inches] <Insert depth>** with a minimum depth of **[1 inch] <Insert depth>** and not exceeding a depth of **[4 inches] <Insert depth>**. Maintain 2 inches of clearance from top of base flashing.

ASTM D5957 sets 24 hours as minimum and 72 hours as maximum duration for flood testing of waterproofing systems.

Flood each area for **[24] [48] [72]** hours.

After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.

Cost of retesting is Contractor's responsibility.

Testing agency to prepare survey report indicating locations of initial leaks, if any, and final survey report.

Infrared Thermography: Testing agency surveys entire roof area using infrared color thermography according to ASTM C1153.

Perform tests before overlying construction is placed.

After infrared scan, locate specific areas of leaks by electrical capacitance/impedance testing or nuclear hydrogen detection tests.

After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

Cost of retesting is Contractor's responsibility.

Testing agency to prepare survey report of initial scan indicating locations of entrapped moisture, if any.

Retain "Electrical Capacitance/Impedance Testing" or "Nuclear Hydrogen Detection Testing" subparagraph with infrared thermography if desired to verify results.

Electrical Capacitance/Impedance Testing: Testing agency surveys entire roof area for entrapped water within roof assembly according to ASTM D7954.

Perform tests before overlying construction is placed.

After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

Cost of retesting is Contractor's responsibility.

Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

Nuclear Hydrogen Detection Testing: Testing agency surveys entire roof area for entrapped water within roof assembly according to ANSI/SPRI/RCI NT-1.

Perform tests before overlying construction is placed.

After testing, repair leaks, repeat tests, and make further repairs until roofing and flashing installations are watertight.

Cost of retesting is Contractor's responsibility.

Testing agency to prepare survey report indicating locations of entrapped moisture, if any.

Retain "Low-Voltage ELD Testing" subparagraph below if required. First option is for platform-type system; second option is also referred to by the trademark brand name EFVM; third option is a handheld device, often used in conjunction with first option to test vertical areas. All options identify specific leak locations and require a conductive medium directly below the exposed roof membrane. See the Evaluations for limitations.

Low-Voltage ELD Testing: Testing agency surveys entire roof area and flashings to locate discontinuities in the roof membrane using low-voltage **[horizontal membrane scanning platform] [membrane electric field vector mapping] [or] [vertical membrane scanning]** in accordance with ASTM D8231.

Perform tests before overlying construction is placed.

After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

Cost of retesting is Contractor's responsibility.

Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

Retain "High-Voltage Membrane Testing" subparagraph below if required. This method requires a dry roof membrane, can be used on vertical surfaces, and identifies specific leak locations.

High-Voltage Membrane Testing: Testing agency surveys entire **[roof area,] [flashings,] [and] [parapet walls]** to locate discontinuity in the roof membrane using an electrically charged metal "broom head."

Perform tests before overlying construction is placed.

After testing, repair areas of discontinuities, repeat tests, and make further repairs until roofing and flashing installations are contiguous.

Cost of retesting is Contractor's responsibility.

Testing agency to prepare survey report indicating locations of initial discontinuities, if any.

A roof inspection is required by manufacturer before warranty issue. Revise scope of inspection and source of report to a qualified roofing consultant or an independent testing agency and inspection if preferred.

* + - * 1. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of the Director’s Representative, and to prepare inspection report.
				2. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
				3. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.
			1. PROTECTING AND CLEANING
				1. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Director’s Representative.
				2. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

Retain paragraph below if using fluid-applied bonding materials.

* + - * 1. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
			1. ROOFING INSTALLER'S WARRANTY

Retain this warranty or include another roofing Installer's warranty form if required. Coordinate with "Warranty" Article.

* + - * 1. WHEREAS \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

Director’s Representative: **<Insert name of Director’s Representative>**.

Director’s Representative Address: **<Insert address>**.

Building Name/Type: **<Insert information>**.

Building Address: **<Insert address>**.

Area of Work: **<Insert information>**.

Acceptance Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Warranty Period: **<Insert time>**.

Expiration Date: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* + - * 1. AND WHEREAS Roofing Installer has contracted (either directly with Director’s Representative or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
				2. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's 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.
				3. This Warranty is made subject to the following terms and conditions:

Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

lightning;

Insert required wind speed in first subparagraph below.

peak gust wind speed exceeding <Insert mph>;

fire;

failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;

faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;

vapor condensation on bottom of roofing; and

activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Director’s Representative.

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 have been paid by Director’s Representative or by another responsible party so designated.

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.

During Warranty Period, if Director’s Representative 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 Director’s Representative engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Director’s Representative 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.

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.

Director’s Representative 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.

This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Director’s Representative from other remedies and resources lawfully available to Director’s Representative 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 Director’s Representative or a subcontract with Director’s Representative’s General Contractor.

* + - * 1. IN WITNESS THEREOF, this instrument has been duly executed this \_\_\_\_\_\_\_\_\_\_\_ day of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Authorized Signature: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Title: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

END OF SECTION 075423