SECTION 07 54 19 – polyvinyl-chloride (pvc) roofing

1. General
   1. SUMMARY
      1. Section Includes:
         1. Adhered polyvinyl chloride (PVC) roofing system.
         2. Mechanically fastened, polyvinyl chloride (PVC) roofing system.
         3. Loosely laid and ballasted, polyvinyl chloride (PVC) roofing system.
         4. Substrate board.
         5. Vapor retarder.
         6. Roof insulation.
         7. Cover board.
         8. Walkways.
      2. Related Requirements:

Retain subparagraph below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

* + - 1. Section 06 10 00 – Rough Carpentry.
      2. Section 06 16 00 – Sheathing, for wood-based, structural-use roof deck panels.
      3. Section 07 21 00 – Thermal Insulation, for insulation beneath the roof deck.
      4. Section 07 62 00 – Sheet Metal Flashing and Trim.
      5. Section 07 71 00 – Roof Specialties, for **[premanufactured copings] [and] [roof edge flashings]**.
      6. Section 07 71 29 – Manufactured Roof Expansion Joints, for premanufactured roof expansion-joint assemblies.
      7. Section 07 92 00 – Joint Sealants.
      8. Section 22 14 23 – Storm Drainage Piping Specialties, for roof drains.
  1. reference standards
     1. American Society for Testing and Materials (ASTM):
        1. ASTM C1177/C1177M-13, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
        2. ASTM D1079-13e1, Standard Terminology Relating to Roofing and Waterproofing.
        3. ASTM D3273-12, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
        4. ASTM D4434/D4434M-12, Standard for Poly (Vinyl Chloride) Sheet Roofing.
        5. ASTM E96/E96M-15, Standard Test Methods for Water Vapor Transmission of Materials.
        6. ASTM E136-12, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 deg C.
        7. ASTM E408-13, Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
     2. Underwriters Laboratories of Canada (ULC):
        1. CAN/ULC-S102-10, Standard Method of Test for Surface Burning Characteristics of Building Materials and Assemblies.
        2. CAN/ULC-S107-10, Standard Methods of Fire Tests of Roof Coverings.
        3. CAN/ULC-S114-05, Standard Method of Test for Determination of Non-Combustibility in Building Materials.
        4. CAN/ULC-S126-06, Standard Method of Test for Fire Spread Under Roof-Deck Assemblies.
        5. CAN/ULC-S701-11, Standard for Thermal Insulation, Polystyrene, Boards and Pipe Covering.
        6. CAN/ULC-S702-14, Standard for Mineral Fibre Thermal Insulation for Buildings.
        7. CAN/ULC-S704-11, Standard for Thermal Insulation, Polyurethane and Polyisocyanurate, Boards, Faced.
     3. Canadian General Standards Board (CGSB):
        1. CAN/CGSB 37.54M, Standard for Polyvinyl Vinyl Chloride Roofing and Waterproofing Membranes.
        2. CAN/CGSB-51.34-M86, Vapour Barrier, Polyethylene Sheet for Use in Building Construction.
     4. Factory Mutual Research Corporation:
        1. Current Edition Approval Guide, Roof Coverings.
        2. FM 4470-10, Approval Standard for Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Non-combustible Roof Deck Construction.
  2. 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.
  3. PREINSTALLATION MEETINGS

Retain "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.

* + - 1. Meet with Owner, Consultant, **[ Construction Manager,]** Owner'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.
      2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
      3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
      4. Review deck substrate requirements for conditions and finishes, including flatness and fastening.
      5. Review structural loading limitations of roof deck during and after roofing.
      6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
      7. Review governing regulations and requirements for insurance and certificates if applicable.
      8. Review temporary protection requirements for roofing system during and after installation.
      9. Review roof observation and repair procedures after roofing installation.
  1. action SUBMITTALS
     1. Product Data: For each type of product.
     2. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
        1. Layout and thickness of insulation.
        2. Base flashings and membrane terminations.
        3. Flashing details at penetrations.
        4. Tapered insulation thickness and slopes.
        5. Roof plan showing orientation of steel roof deck and orientation of roof membrane, fastening spacings, and patterns for mechanically fastened roofing system.
        6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
        7. Tie-in with air barrier.
     3. Samples for Verification: For the following products:
        1. Roof membrane and flashing, of colour required.
        2. Aggregate surfacing material in gradation and colour required.
        3. Roof paver, full sized, in each colour and texture required.
        4. Walkway pads or rolls, of colour required.
     4. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.
  2. INFORMATIONAL SUBMITTALS
     1. Qualification Data: For Installer and manufacturer.
     2. Manufacturer Certificates:
        1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
           1. Submit evidence of compliance with performance requirements.
        2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
     3. Product Test Reports: For roof membrane and insulation, tests performed by independent qualified testing agency indicating compliance with specified requirements.
     4. Evaluation Reports: For components of roofing system, from ICC-ES.
     5. Field Test Reports:
        1. Concrete internal relative humidity test reports.
        2. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.

Retain "Field quality-control reports" Paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + 1. Field quality-control reports.
    2. Sample Warranties: For manufacturer's special warranties.
  1. CLOSEOUT SUBMITTALS
     1. 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.

* + 1. 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

Second option in "Manufacturer Qualifications" Paragraph below applies only to concrete, light weight insulation concrete, and steel roof decks. Third option applies to concrete, lightweight insulating concrete, cementitious wood fiber, steel, and wood roof decks. See the Evaluations.

* + 1. Manufacturer Qualifications: A qualified manufacturer that is ULC listed for roofing system identical to that used for this Project.
    2. Installer Qualifications: 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.
    3. Conform to CRCA's Roofing Specifications manual as amended to date of this Specification, except where indicated or specified otherwise. Do roofing work employing roofing Products, roof sheathing, plates, and fasteners for proposed roofing system. More stringent requirements in Consultant's opinion governs.
    4. Conform to CRCA's Roofing Specifications manual as amended to date of this Specification, except where indicated or specified otherwise.
  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.
        1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
     3. 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.
     4. Store adhesives and emulsion-based waterproofing mastics at a minimum +5 degree C. Store adhesives and solvent-based mastics at sufficiently high temperatures to ensure ease of application.
     5. Materials delivered in rolls will be carefully stored upright; flashing will be stored to avoid creasing, buckling, scratches or any other possible damage.
     6. Avoid material overloads which may affect the structural integrity of specific roof areas.
     7. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.
  2. field conditions
     1. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit assembly of metal panels to be performed according to manufacturers' written instructions and warranty requirements.
     2. Do not apply roofing system during inclement weather.
     3. Do not apply roofing system to dirty, dust, wet, damp, or frozen deck surface.
     4. The contractor shall follow all safety regulations as recommended by WHIMIS and the applicable authorities having jurisdiction.
     5. Contractor shall verify that all roof drain lines are unblocked and cleared before starting work. Report any such blockages to the Consultant in writing.
     6. If any unusual or concealed condition is discovered, stop work and notify the Consultant immediately in writing.
     7. Site clean-up, including building areas that have been affected by construction, shall be completed to the Consultant's satisfaction.
  3. WARRANTY

When warranties are required, verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner 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.

* + - 1. Special warranty includes roof membrane, base flashings, **[roof insulation,] [fasteners,] [cover boards,] [substrate board,] [roof pavers,]** and other components of roofing system.

Verify available warranties and warranty periods.

* + - 1. Warranty Period: **[10] [15] [20] [30]** 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.

* + - 1. Warranty Period: **[Two] <Insert number>** years commencing from date of Substantial Performance of the Work and agree to Make Good promptly any defects which occur or become apparent within warranty period in conjunction with membrane manufacturer's warranty. Ensure warranty is on CRCA's or OIRCA's Standard Form of Warranty.

1. Products

Manufacturers and products listed are neither recommended nor endorsed by the AIA or Deltek.. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 01 61 00 – Common Product Requirements.

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

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

* + - 1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G152, ASTM G154, or ASTM G155.
      2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D3746, ASTM D4272/D4272M, or the "Resistance to Foot Traffic Test" in FM Approvals 4470.
    1. Material Compatibility: Roofing materials shall 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 on Drawings.

* + - 1. Zone 1 (Roof Area Field): <Insert lbf/sq. ft. (kPa/sq. m)>.
      2. Zone 2 (Roof Area Perimeter): <Insert lbf/sq. ft. (kPa/sq. m)>.
         1. Location: From roof edge to <Insert dimension> inside roof edge.
      3. Zone 3 (Roof Area Corners): <Insert lbf/sq. ft. (kPa/sq. m)>.
         1. Location: <Insert dimension> in each direction from building corner.

Retain either "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 will 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 listing 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 shall comply with requirements in FM Approvals 4450 or FM Approvals 4470 as part of a roofing system and shall be 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. Other options for classifications increase in increments of 15 (for example, Classes 1A-135, 1A-150, 1A-165, and higher). "Class 1A" signifies compliance with ASTM E108, Class A fire performance for FM Approvals-approved Class 1 roof covers.

* + - 1. 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.

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

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

"Solar Reflectance Index" Paragraph below applies to LEED 2009. First option is minimum for roofs with slopes of 2:12 or less; second option is for roofs with slopes steeper than 2:12.

* + 1. Solar Reflectance Index: Not less than **[78] [29]** when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

"Solar Reflectance Index (SRI)" Paragraph below applies to LEED v4. First of each pair of options is minimum for roofs with slopes of 2:12 or less; second of each pair of options is for roofs with slopes steeper than 2:12.

* + 1. Solar Reflectance Index (SRI): Three-year-aged SRI not less than **[64] [32]** or initial SRI not less than **[82] [39]** when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

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 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. POLYVINYL CHLORIDE (PVC) ROOFING

Retain one of five "PVC Sheet" paragraphs below.

Retain first "PVC Sheet" Paragraph below for Type III PVC membrane.

* + 1. PVC Sheet: ASTM D4434/D4434M, Type III, fabric reinforced.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=12917&mf=04&src=wd): Subject to compliance with requirements, **[provide products by the following**] **[provide products by one of the following**] **[available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Carlisle SynTec Incorporated](http://www.specagent.com/LookUp/?uid=123457147017&mf=04&src=wd).
         2. [Cooley Engineered Membranes](http://www.specagent.com/LookUp/?uid=123457147012&mf=04&src=wd).
         3. [Duro-Last Roofing, Inc](http://www.specagent.com/LookUp/?uid=123457147023&mf=04&src=wd).
         4. [Flex Membrane International Corp.](http://www.specagent.com/LookUp/?uid=123457147019&mf=04&src=wd)
         5. [GAF](http://www.specagent.com/LookUp/?uid=123457147020&mf=04&src=wd).
         6. [Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/LookUp/?uid=123457147014&mf=04&src=wd).
         7. [Mule-Hide Products Co., Inc](http://www.specagent.com/LookUp/?uid=123457147015&mf=04&src=wd).
         8. [Sika Sarnafil](http://www.specagent.com/LookUp/?uid=123457147021&mf=04&src=wd).
         9. [Versico Roofing Systems](http://www.specagent.com/LookUp/?uid=123457147016&mf=04&src=wd).
         10. <**Insert manufacturer's name**>.

Retain one thickness in "Thickness" Subparagraph below or revise to suit Project. ASTM D4434/D4434M, Type II and Type III minimum thicknesses are both 45 mils (1.1 mm). Other thicknesses include 50, 60, 72, 80, and 96 mils (1.27, 1.5, 1.8, 2.0, and 2.4 mm); verify availability with manufacturers.

* + - 1. Thickness: [50 mils (1.27 mm)] [60 mils (1.5 mm)] [80 mills (2.0 mm)] <**Insert value**>.

Retain one colour in "Exposed Face Colour" Subparagraph below. Verify availability with manufacturers.

* + - 1. Exposed Face Colour: [**White**] [**Gray**] <**Insert colour**>.

Retain "Recycled Content" Subparagraph below to specify recycled content if required. An alternative method of requiring recycled content is to retain requirement in Project's Division 01 sustainable design requirements Section that gives Contractor the option and responsibility to determine how recycled content requirements will be met.

* + - 1. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than <**Insert value**> percent.

Retain first "PVC Sheet" Paragraph below for Type III fleece-backed PVC membrane.

* + 1. PVC Sheet: ASTM D4434/D4434M, Type III, fabric reinforced, and fabric backed.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=12920&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Carlisle SynTec Incorporated](http://www.specagent.com/LookUp/?uid=123457147038&mf=04&src=wd).
         2. [Duro-Last Roofing, Inc](http://www.specagent.com/LookUp/?uid=123457147037&mf=04&src=wd).
         3. [Flex Membrane International Corp.](http://www.specagent.com/LookUp/?uid=123457147039&mf=04&src=wd)
         4. [GAF](http://www.specagent.com/LookUp/?uid=123457147040&mf=04&src=wd).
         5. [Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/LookUp/?uid=123457147041&mf=04&src=wd).
         6. [Versico Roofing Systems](http://www.specagent.com/LookUp/?uid=123457147042&mf=04&src=wd).
         7. <**Insert manufacturer's name**>.

Retain one thickness in "Thickness" Subparagraph below; verify availability with manufacturers.

* + - 1. Membrane Thickness: [50 mils (1.27 mm)] [60 mils (1.5 mm)] [80 mils (2.0 mm)] <**Insert value**>.

Retain one colour in "Exposed Face Colour" Subparagraph below. Verify availability with manufacturers.

* + - 1. Exposed Face Colour: [**White**] [**Gray**] <**Insert colour**>.

Retain "Recycled Content" Paragraph below to specify recycled content if required. An alternative method of requiring recycled content is to retain requirement in Project's Division 01 sustainable design requirements Section that gives Contractor the option and responsibility to determine how recycled content requirements will be met.

* + - 1. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than <**Insert value**> percent.

Retain first "PVC Sheet" Paragraph below for Type II PVC membrane; retain Sika Saranfil's "Sarnafil G410" for adhered installations.

* + 1. PVC Sheet: ASTM D4434/D4434M, Type II, glass-fiber reinforced, felt backed.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=12919&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] **[provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Sika Sarnafil](http://www.specagent.com/LookUp/?uid=123457147034&mf=04&src=wd).
         2. <**Insert manufacturer's name**>.

Retain one thickness in "Thickness" Subparagraph below or revise to suit Project. Verify availability with manufacturers.

* + - 1. Thickness: [60 mils (1.5 mm)] [72 mils (1.8 mm)] [80 mils (2.0 mm)] <**Insert value**>.

Retain one colour in "Exposed Face Colour" Subparagraph below. Colours are made to order. Verify availability with manufacturers.

* + - 1. Exposed Face Colour: **[Copper brown] [Evergreen] [Lead gray] [Patina green] <Insert colour>**.

Retain "Recycled Content" Subparagraph below to specify recycled content if required. An alternative method of requiring recycled content is to retain requirement in Project's Division 01 sustainable design requirements Section that gives Contractor the option and responsibility to determine how recycled content requirements will be met.

* + - 1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

Retain first "PVC Sheet" Paragraph below for Type II fleece-backed PVC membrane for adhered installations.

* + 1. PVC Sheet: ASTM D4434/D4434M, Type II, reinforced, fabric backed.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=12922&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Carlisle SynTec Incorporated](http://www.specagent.com/LookUp/?uid=123457147044&mf=04&src=wd).
         2. <**Insert manufacturer's name**>.

Retain one thickness in "Thickness" Subparagraph below or revise to suit Project. Verify availability with manufacturers.

* + - 1. Thickness: [50 mils (1.27 mm)] [60 mils (1.5 mm)] [80 mils (2.0 mm)] <**Insert value**>.
      2. Exposed Face Colour: White.

Retain "Recycled Content" Subparagraph below to specify recycled content if required. An alternative method of requiring recycled content is to retain requirement in Project's Division 01 sustainable design requirements Section that gives Contractor the option and responsibility to determine how recycled content requirements will be met.

* + - 1. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than <**Insert value**> percent.

Retain "PVC Sheet" Paragraph below for Type IV PVC membranes.

* + 1. PVC Sheet: ASTM D4434/D4434M, Type IV, fabric reinforced.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=12918&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] **[provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Duro-Last Roofing, Inc](http://www.specagent.com/LookUp/?uid=123457147026&mf=04&src=wd).
         2. <**Insert manufacturer's name**>.
      2. Thickness: [40 mils (1.0 mm)] <**Insert value**>.

Retain one colour in "Exposed Face Colour" Subparagraph below. Verify availability with manufacturers.

* + - 1. Exposed Face Colour: [**White**] [**Tan**] [**Gray**] [**Dark gray**] <**Insert colour**>.

Retain "Recycled Content" Subparagraph below to specify recycled content if required. An alternative method of requiring recycled content is to retain requirement in Project's Division 01 sustainable design requirements Section that gives Contractor the option and responsibility to determine how recycled content requirements will be met.

* + - 1. Recycled Content: Postconsumer recycled content plus one-half of pre-consumer recycled content not less than <**Insert value**> percent.

Retain first "PVC Keytone Ethylene Ester (KEE) Alloy Sheet" Paragraph below for PVC membrane with DuPont's "Elvaloy" KEE polymer.

* + 1. PVC Keytone Ethylene Ester (KEE) Alloy Sheet: ASTM D4434/D4434M, Type III.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=12923&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Carlisle SynTec Incorporated](http://www.specagent.com/LookUp/?uid=123457147045&mf=04&src=wd).
         2. [Duro-Last Roofing, Inc](http://www.specagent.com/LookUp/?uid=123457147047&mf=04&src=wd).
         3. [Flex Membrane International Corp.](http://www.specagent.com/LookUp/?uid=123457147048&mf=04&src=wd)
         4. [GAF](http://www.specagent.com/LookUp/?uid=123457147049&mf=04&src=wd).
         5. [Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/LookUp/?uid=123457147050&mf=04&src=wd).
         6. [Mule-Hide Products Co., Inc](http://www.specagent.com/LookUp/?uid=123457147051&mf=04&src=wd).
         7. [Versico Roofing Systems](http://www.specagent.com/LookUp/?uid=123457147052&mf=04&src=wd).
         8. <**Insert manufacturer's name**>.
      2. Membrane Thickness: [50 mils (1.27 mm)] [60 mils (1.50 mm)] [80 mils (2.0 mm)] <**Insert value**>.

Retain one colour in "Exposed Face Colour" Subparagraph below. Verify availability with manufacturers.

* + - 1. Exposed Face Colour: [**White**] [**Tan**] [**Gray**] <**Insert colour**>.

Retain "Recycled Content" Subparagraph below to specify recycled content if required. An alternative method of requiring recycled content is to retain requirement in Project's Division 01 sustainable design requirements Section that gives Contractor the option and responsibility to determine how recycled content requirements will be met.

* + - 1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

Retain "PVC Keytone Ethylene Ester (KEE) Alloy Sheet" Paragraph below for PVC membrane with DuPont's "Elvaloy" KEE polymer with fabric backing.

* + 1. PVC Keytone Ethylene Ester (KEE)- Alloy Sheet: ASTM D4434/D4434M, Type III, with fabric backing.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=12924&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Carlisle SynTec Incorporated](http://www.specagent.com/LookUp/?uid=123457147053&mf=04&src=wd).
         2. [Flex Membrane International Corp.](http://www.specagent.com/LookUp/?uid=123457147054&mf=04&src=wd)
         3. [GAF](http://www.specagent.com/LookUp/?uid=123457147055&mf=04&src=wd).
         4. <**Insert manufacturer's name**>.
      2. Membrane Thickness: [50 mils (1.27 mm)] [60 mils (1.50 mm)] [80 mils (2.0 mm)] <**Insert value**>.

Retain one colour in "Exposed Face Colour" Subparagraph below. Verify availability with manufacturers.

* + - 1. Exposed Face Colour: [**White**] [**Tan**] [**Gray**] <**Insert colour**>.

Retain "Recycled Content" Subparagraph below to specify recycled content if required. An alternative method of requiring recycled content is to retain requirement in Project's Division 01 sustainable design requirements Section that gives Contractor the option and responsibility to determine how recycled content requirements will be met.

* + - 1. Recycled Content: Postconsumer recycled content plus one-half of preconsumer recycled content not less than <**Insert value**> percent.

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

* + - 1. Source Limitations: Obtain components for roofing system from [**roof membrane manufacturer**] [**or**] [**manufacturers approved by roof membrane manufacturer**].
  1. AUXILIARY ROOFING MATERIALS
     1. General: Auxiliary 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.

* + - 1. Adhesives and Sealants: Comply with VOC limits of authorities having jurisdiction.

Subparagraph below applies to LEED 2009 NC, CI, and CS; LEED v4; IgCC; ASHRAE 189.1; and Green Globes.

* + - 1. Adhesives and sealants shall comply with the following limits for VOC content:
         1. Plastic Foam Adhesives: 50 g/L.
         2. Gypsum Board and Panel Adhesives: 50 g/L.
         3. Multipurpose Construction Adhesives: 70 g/L.
         4. Fiberglass Adhesives: 80 g/L.
         5. Contact Adhesives: 80 g/L.
         6. PVC Welding Compounds: 510 g/L.
         7. Other Adhesives: 250 g/L.
         8. Single-Ply Roof Membrane Sealants: 450 g/L.
         9. Nonmembrane Roof Sealants: 300 g/L.
         10. Sealant Primers for Nonporous Substrates: 250 g/L.
         11. Sealant Primers for Porous Substrates: 775 g/L.

Subparagraph below applies to LEED v4.

* + - 1. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

Subparagraph below applies to ASHRAE 189.1.

* + - 1. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    1. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and colour as PVC sheet.
    2. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
    3. Roof Vents: As recommended by roof membrane manufacturer.
       1. Size: Not less than 4-inch (100-mm) diameter.

Retain "Bonding Adhesive" Paragraph below for adhering standard PVC membranes and flashings to substrate. Also retain paragraph for adhering perimeters of mechanically fastened or loosely laid and ballasted membranes if applicable. Before retaining option in paragraph, 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 "Water-Based, Fabric-Backed Membrane Adhesive" or "Low-Rise, Urethane, Fabric-Backed Membrane Adhesive" Paragraph below to adhere fabric-backed PVC roof membrane. First paragraph describes proprietary cold-applied adhesive. Third paragraph describes a proprietary spray-applied, low-rise urethane.

* + 1. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.

Retain one of two "Slip Sheet" paragraphs below if slip sheets are required. NRCA recommends separator sheets between non-fabric-backed PVC membranes and the substrate, including extruded- and molded (expanded) polystyrene insulation, asphalt-based products, and coal-tar products. See roofing system manufacturer's specifications for requirements. Retain first paragraph over cementitious wood-fiber roof decks if required by roof membrane manufacturer.

* + 1. Slip Sheet: ASTM D2178/D2178M, Type IV, glass fiber, asphalt-impregnated felt.
    2. Slip Sheet: Manufacturer's standard, of thickness required for application.

Retain "Vented Base Sheet" Paragraph below for lightweight insulating concrete roof decks.

* + 1. Vented Base Sheet: ASTM D4897/D4897M, 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 (25 by 3 mm) 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 (25 mm wide by 1.3 mm thick), pre-punched.
    4. Ballast Retaining Bar: Perimeter securement system consisting of a slotted extruded-aluminum retention bar with an integrated compression fastening strip.
       1. Fasteners: 1-1/2-inch (38-mm) stainless steel fasteners with neoprene washers.
    5. 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.
    6. 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 BOARDS
     1. Substrate Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum substrate or ASTM C1278/C1278M, fiber-reinforced gypsum board.
        1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=5110&mf=04&src=wd): Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
           1. [CertainTeed Corporation](http://www.specagent.com/LookUp/?uid=123457147059&mf=04&src=wd).
           2. [Georgia-Pacific Gypsum LLC](http://www.specagent.com/LookUp/?uid=123457147058&mf=04&src=wd).
           3. [National Gypsum Company](http://www.specagent.com/LookUp/?uid=123457147060&mf=04&src=wd).
           4. [USG Corporation](http://www.specagent.com/LookUp/?uid=123457147062&mf=04&src=wd).
        2. Thickness: [1/4 inch (6 mm)] [1/2 inch (13 mm)] [**Type X,** 5/8 inch (16 mm)].
        3. Surface Finish: [**Factory primed**] [**Unprimed**].
     2. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate board to roof deck.
  2. 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 (0.15 mm)] [10 mils (0.25 mm)] thick, minimum, with maximum permeance rating of [0.13 perm (0.084 metric perm)] [0.76 perm (0.050 metric perm)].

Retain "Tape" or "Adhesive" Subparagraph below.

* + - 1. Tape: Pressure-sensitive tape of type recommended by vapor retarder manufacturer for sealing joints and penetrations in vapor retarder.
      2. Adhesive: Manufacturer's standard lap adhesive, listed by FM Approvals for vapor retarder application.

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

Retain first "Self-Adhering-Sheet Vapor Retarder" Paragraph below if rubberized asphalt adhesive is required; retain second if butyl rubber adhesive is required. Butyl rubber adhesive might be used in hot desert or high-altitude climates.

* + 1. Self-Adhering-Sheet Vapor Retarder: ASTM D1970/D1970M, polyethylene film laminated to layer of rubberized asphalt adhesive, minimum 40-mil- (1.0-mm-) total thickness; maximum permeance rating of 0.1 perm (6 ng/Pa x s x sq. m); cold applied, with slip-resisting surface and release paper backing. Provide primer when recommended by vapor retarder manufacturer.
  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 PVC 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 and plaza decks, or other installations requiring high compressive strength insulation.

* + 1. Extruded-Polystyrene Board Insulation: ASTM C578, [**Type IV,** 1.45-lb/cu. ft. (23-kg/cu. m)] [**minimum density,** 25-psi (173-kPa) **minimum compressive strength**] [**Type V,** 3.00-lb/cu. ft. (48-kg/cu. m) **minimum density,** 100-psi (690-kPa) **minimum compressive strength**], square edged.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=8992&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [DiversiFoam Products](http://www.specagent.com/LookUp/?uid=123457147064&mf=04&src=wd).
         2. [Dow Chemical Company (The)](http://www.specagent.com/LookUp/?uid=123457147065&mf=04&src=wd).
         3. [Kingspan Insulation Limited](http://www.specagent.com/LookUp/?uid=123457147067&mf=04&src=wd).
         4. [Owens Corning](http://www.specagent.com/LookUp/?uid=123457147066&mf=04&src=wd).
         5. <**Insert manufacturer's name**>.
      2. Thermal Resistance: R-value of 5.0 per inch (25.4 mm).

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

* + - 1. Size: [48 by 48 inches (1219 by 1219 mm)] [48 by 96 inches (1219 by 2438 mm)].

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

* + - 1. Thickness:
         1. Base Layer: [1-1/2 inches (38 mm)] <**Insert thickness**>.
         2. Upper Layer: <**Insert thickness**>.

Retain "Molded (Expanded) Polystyrene Board Insulation" Paragraph below for noncomposite, unfaced, molded (expanded) 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. (22 kg/cu. m), a minimum compressive strength of 15 psi (104 kPa), and a thermal resistance of 4.0 per inch (25.4 mm). 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. (18-kg/cu. m) minimum density, 13-psi (90-kPa) minimum compressive strength, square edge.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=8993&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Carlisle SynTec Incorporated](http://www.specagent.com/LookUp/?uid=123457146984&mf=04&src=wd).
         2. [DiversiFoam Products](http://www.specagent.com/LookUp/?uid=123457146985&mf=04&src=wd).
         3. [Dyplast Products](http://www.specagent.com/LookUp/?uid=123457146986&mf=04&src=wd).
         4. [Insulfoam - a division of Carlisle Construction Materials Inc.](http://www.specagent.com/LookUp/?uid=123457146987&mf=04&src=wd)
         5. <**Insert manufacturer's name**>.
      2. Thermal Resistance: R-value of 3.8 per inch (25.4 mm).

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

* + - 1. Size: [48 by 48 inches (1219 by 1219 mm)] [48 by 96 inches (1219 by 2438 mm)].

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

* + - 1. Thickness:
         1. Base Layer: [1-1/2 inches (38 mm)] <**Insert thickness**>.
         2. Upper Layer: <**Insert thickness**>.

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

* + 1. Composite Molded (Expanded) Polystyrene Board Insulation: ASTM C578, [**Type II,** 1.35-lb/cu. ft. (22-kg/cu. m)] [**Type VIII,** 1.15-lb/cu. ft. (18-kg/cu. m)] [**Type IX,** 1.8-lb/cu. ft. (29-kg/cu. m)] minimum density, with factory-applied facings, as follows:

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=11979&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] **[provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [ACH Foam Technologies, Inc.](http://www.specagent.com/LookUp/?uid=123457147007&mf=04&src=wd)
         2. [AFM Corporation](http://www.specagent.com/LookUp/?uid=123457147008&mf=04&src=wd).
         3. [Cellofoam North America, Inc.](http://www.specagent.com/LookUp/?uid=123457147011&mf=04&src=wd)
         4. [Insulfoam - a division of Carlisle Construction Materials Inc.](http://www.specagent.com/LookUp/?uid=123457147010&mf=04&src=wd)
         5. <**Insert manufacturer's name**>.

Retain one of two "Facer" Subparagraphs below, or revise to include another board facer if required. Verify availability with manufacturers.

* + - 1. Facer: ASTM C208, Type II, Grade 2, cellulosic-fiber insulation board, asphalt coated, 1/2 inch (13 mm) thick.
      2. Facer: DOC PS 2, Exposure 1, oriented strand board, 7/16 inch (11 mm) thick.

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

* + - 1. Size: [48 by 48 inches (1219 by 1219 mm)] [48 by 96 inches (1219 by 2438 mm)].
      2. 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 and revise "Compressive Strength" Subparagraph to 25 psi (172 kPa). 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: Square edged, closed cell polyisocyanurate foam manufactured using Hydrocabon (HC), Zero Ozone Depleting Potential (ZeroODP) HCFC free blowing agents and integrally laminated to heavy, non-asphaltic, fibre reinforced, felt facers, meeting requirements of CAN/ULC-S704, Type 3, CAN/ULC-S126 and CAN/ULC-S107. Provide following:
       1. Multiple Layers: Ensure maximum thickness for 1 layer of insulation is 50 mm (2") having compressive strength of 140 kPa (20 psi).
       2. Dimension Stability: 2% maximum linear change when conditioned at 70 deg C (158 deg F) and 97% relative humidity for 7 Days; curing time 24 hours minimum, plus an additional 24 hours minimum per inch (25 mm) of thickness, at a minimum of 16 deg C (60 deg F) before shipment from manufacturer.
       3. Ensure maximum board size for loose laid and mechanically attached insulation boards is 1200 mm x 2400 mm (4' x 8'), maximum board size for insulation boards adhered to substrate is 1200 mm x 1200 mm (4' x 4').
       4. Ensure insulation is without limitations devoid of face-sheet delamination, edge cavitation, cupping, bowing, crushing or powdering. Provide thermal value and in multiple layers to thickness shown on Drawings.
       5. Basis of Design Product: Atlas ACFOAM III

Mineral wood 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. (180-kg/cu. m) density, and a lower layer of 7.5-lb/cu. ft. (120-kg/cu. m) density.
       1. Thermal Resistance: R-value of 3.8 per inch (25.4 mm).
       2. Size: 48 by 48 inches (1219 by 1219 mm).

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

* + - 1. Thickness:
         1. Base Layer: [2 inches (50 mm)] <**Insert thickness**>.
         2. Upper Layer: <**Insert thickness**>.

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

* + - 1. 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.
       1. Material: [Match roof insulation] <Insert material>.
       2. Minimum Thickness: 1/4 inch (6.35 mm).
       3. Slope:
          1. Roof Field: [1/4 inch per foot (1:48)] <**Insert slope**> unless otherwise indicated on Drawings.
          2. Saddles and Crickets: [1/2 inch per foot (1:24)] <**Insert slope**> unless otherwise indicated on Drawings.
  1. INSULATION ACCESSORIES
     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 and 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.
    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.

* + - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
      2. Bead-applied, low-rise, one-component, or multicomponent urethane adhesive.
      3. Full-spread, spray-applied, low-rise, two-component urethane adhesive.
      4. Adhesives and sealants shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
    1. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.

Retain "Manufacturers" Subparagraph below and list of manufacturers to require products from manufacturers listed or a comparable product from other manufacturers.

* + - 1. [Manufacturers](http://www.specagent.com/LookUp/?ulid=5112&mf=04&src=wd): Subject to compliance with requirements, [**provide products by the following**] [**provide products by one of the following**] [**available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following**]:
         1. [Georgia-Pacific Gypsum LLC](http://www.specagent.com/LookUp/?uid=123457147076&mf=04&src=wd).
         2. [National Gypsum Company](http://www.specagent.com/LookUp/?uid=123457147078&mf=04&src=wd).
         3. [USG Corporation](http://www.specagent.com/LookUp/?uid=123457147080&mf=04&src=wd).
      2. Thickness: [1/4 inch (6 mm)] [1/2 inch (13 mm)] [5/8 inch (16 mm)].
      3. Surface Finish: [**Factory primed**] [**Unprimed**].

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/D312M, Type III or Type IV] [ASTM D6152/D6152M, SEBS modified].
  1. BALLAST

Retain this article for loosely laid and ballasted installations. Verify, with roof membrane manufacturer, that loosely laid and ballasted systems are acceptable.

* + 1. Aggregate Ballast: Smooth, washed, riverbed gravel or other acceptable smooth-faced stone that withstands weather exposure without significant deterioration and does not contribute to membrane degradation.
    2. Heavyweight Roof Pavers: Heavyweight, hydraulically pressed concrete units, square edged, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67.

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 (300 by 300 and 450 by 450 mm).

* + - 1. Size: [24 by 24 inches (600 by 600 mm)]. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch (1.6 mm) in length, height, and thickness.

Retain one of three options in "Colours and Textures" Subparagraph below. If retaining first option, indicate colours and textures in a separate schedule.

* + - 1. Colours and Textures: [As indicated by manufacturer's designations] [Match Consultant's samples] [As selected by Consultant 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 (5 mm) thick and acceptable to roofing system manufacturer.
       1. Size: Approximately 36 by 60 inches (914 by 1524 mm).

Colour: Contrasting with roof membrane.

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.
         1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
         2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.

Retain first subparagraph below for steel roof deck.

* + - 1. 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.

* + - 1. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
      2. 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.
         1. Test Frequency: One test probe per each [1000 sq. ft. (93 sq. m)], or portion thereof, of roof deck, with no fewer than three test probes.
         2. Submit test reports within 24 hours of performing tests.
      3. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
      4. Verify that joints in precast concrete roof decks have been grouted flush with top of concrete.
    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 0.0295 inch (0.749 mm) thick.

* + 1. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
       1. Submit test result within 24 hours of performing tests.
          1. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.
  1. INSTALLATION OF ROOFING, GENERAL

First option in first paragraph below applies only to concrete, lightweight insulation 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**] CRCA's Roofing Manual 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 (610 mm) in adjacent rows.

Retain first subparagraph below for steel roof decks.

* + - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
         1. Locate end joints over crests of steel roof deck.
      2. Tightly butt substrate boards together.
      3. 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.

* + - 1. 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**] and FM Global Property Loss Prevention Data Sheet 1-29.
      2. 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.
  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, normalweight 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 (50 and 150 mm), respectively.
       1. Extend vertically up parapet walls and projections to a minimum height equal to height of the insulation and cover board.
       2. Continuously seal side and end laps with [**tape**] [**adhesive**].
    2. 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 (90 and 150 mm), respectively.
       1. Extend vertically up parapet walls and projections to a minimum height equal to height of insulation and cover board.
       2. Seal laps by rolling.

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 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 (1219-by-1219-mm) insulation boards. Retain second option for 48-by-96-inch (1219-by-2438-mm) insulation boards. Retain third option with second option when insulation is installed directly over metal roof decks.

* + - 1. Install base layer of insulation with [joints staggered not less than 24 inches (610 mm) in adjacent rows] [end joints staggered not less than 12 inches (305 mm) 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.

* + - * 1. Locate end joints over crests of decking.

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

* + - * 1. Where installing composite and non-composite insulation in two or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
        2. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
        3. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
        4. 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 (610 mm).

Trim insulation so that water flow is unrestricted.

* + - * 1. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
        2. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

Retain first subparagraph below for loosely laid and ballasted roofing systems.

* + - * 1. 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.

* + - * 1. 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.

* + - 1. Install upper layers of insulation[**and tapered insulation**] with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.

Retain first subparagraph below for 48-by-48-inch (1219-by-1219-mm) insulation boards.

* + - * 1. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.

Retain first subparagraph below and delete last subparagraph above for 48-by-96-inch (1219-by-2436-mm) insulation boards.

* + - * 1. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
        2. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
        3. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
        4. 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 (610 mm).
        5. Trim insulation so that water flow is unrestricted.
        6. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
        7. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

Usually retain first subparagraph below for loosely laid and ballasted roofing systems.

* + - * 1. Loosely lay each layer of insulation units over substrate.

Retain first subparagraph below with mechanically attached base layer insulation.

* + - * 1. Adhere each layer of insulation to substrate using adhesive according to [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**] 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 (14 deg C) 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 (1219-by-1219-mm) insulation boards; second option for 48-by-96-inch (1219-by-2438-mm) insulation boards.

* + - 1. Install base layer of insulation with [joints staggered not less than 24 inches (610 mm) in adjacent rows] [end joints staggered not less than 12 inches (305 mm) 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.

* + - * 1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
        2. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
        3. 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 (610 mm).

Trim insulation so that water flow is unrestricted.

* + - * 1. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
        2. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

Retain first subparagraph below for loosely laid and ballasted roofing systems.

* + - * 1. 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.

* + - * 1. 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. (0.3 L/sq. m) and allow primer to dry.

Set insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) 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.

* + - 1. Install upper layers of insulation [**and tapered insulation**] with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.

Retain first subparagraph below for 48-by-48-inch (1219-by-1219-mm) insulation boards.

* + - * 1. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.

Retain first subparagraph below and delete last subparagraph above for 48-by-96-inch (1219-by-2438-mm) insulation boards.

* + - * 1. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
        2. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
        3. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
        4. 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 (610 mm).

Trim insulation so that water flow is unrestricted.

* + - * 1. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
        2. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

Usually retain first subparagraph below for loosely laid and ballasted roofing systems.

* + - * 1. Loosely lay each layer of insulation units over substrate.

Retain first subparagraph below with adhered base layer insulation.

* + - * 1. 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 (14 deg C) 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:
       1. Mechanically fasten vented base sheet to lightweight insulating concrete roof deck, 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.

* + - * 1. 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].
        2. Fasten vented base sheet to resist 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 roof deck.

In first subparagraph below, retain first option for 48-by-48-inch (1219-by-1219-mm) insulation boards; second option for 48-by-96-inch (1219-by-2438-mm) insulation boards.

* + - 1. Install base layer of insulation with [joints staggered not less than 24 inches (610 mm) in adjacent rows] [end joints staggered not less than 12 inches (305 mm) in adjacent rows].

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

* + - * 1. Where installing composite and non-composite insulation in two or more layers, install non-composite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
        2. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
        3. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
        4. 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 (610 mm).

Trim insulation so that water flow is unrestricted.

* + - * 1. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
        2. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

Retain first subparagraph below for loosely laid and ballasted roofing systems.

* + - * 1. 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.

* + - * 1. 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 (14 deg C) 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.

* + - 1. Install upper layers of insulation [**and tapered insulation**] with joints of each layer offset not less than 12 inches (305 mm) from previous layer of insulation.

Retain first subparagraph below for 48-by-48-inch (1219-by-1219-mm) insulation boards.

* + - * 1. Staggered end joints within each layer not less than 24 inches (610 mm) in adjacent rows.

Retain first subparagraph below and delete last subparagraph above for 48-by-96-inch (1219-by-2438-mm) insulation boards.

* + - * 1. Install with long joints continuous and with end joints staggered not less than 12 inches (305 mm) in adjacent rows.
        2. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
        3. Make joints between adjacent insulation boards not more than 1/4 inch (6 mm) in width.
        4. 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 (610 mm).

Trim insulation so that water flow is unrestricted.

* + - * 1. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
        2. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.

Usually retain first subparagraph below for loosely laid and ballasted roofing systems.

* + - * 1. Loosely lay each layer of insulation units over substrate.

Retain first subparagraph below with adhered base layer insulation.

* + - * 1. 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 (14 deg C) 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.

* + 1. Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing, and maintaining insulation in place.
  1. INSTALLATION OF COVER BOARDS

For reroofing applications where a portion of exiting roofing system remains (re-covering), retitle this Article "Installation of Recovery Board," revise "cover board" to "recovery board" in subsequent paragraphs and subparagraphs, and 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 (150 mm) in each direction.
       1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
       2. At internal roof drains, conform to slope of drain sump.
          1. Trim cover board so that water flow is unrestricted.
       3. Cut and fit cover board tight to nailers, projections, and penetrations.

Retain first subparagraph below with adhered insulation. First option below applies only to concrete, lightweight insulation 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. Adhere cover board to substrate using adhesive according to [**FM Approvals' RoofNav listed roof assembly requirements for specified Windstorm Resistance Classification**] 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.

* + - * 1. Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F (14 deg C) of equiviscous temperature.

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

* + - * 1. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing, and maintaining insulation in place.
        2. 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 immediately beneath roof membrane.
  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 [**Owner'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 "Fabric-Backed Roof Membrane Adhesive" Paragraph below for adhering fabric-backed roof membrane to substrate.

* + 1. Fabric-Backed Roof Membrane Adhesive: Apply to substrate at rate required by manufacturer and install fabric-backed roof membrane.
    2. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
    3. Apply roof membrane with side laps shingled with slope of roof deck where possible.
    4. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
       1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.

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

* + - 1. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
      2. 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 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. Limit 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 Owner'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 PVC sheet using fastening plates or metal battens centered within seam, and mechanically fasten PVC 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.
       1. 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.

* + - 1. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
      2. 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 LOOSELY LAID AND BALLASTED ROOF MEMBRANE

Verify, with roof membrane manufacturer, that loosely laid and ballasted systems are acceptable.

* + 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 Owner'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 roofing 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.

* + - 1. At corners and perimeters, omit aggregate ballast leaving roof membrane exposed.
      2. 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.
       1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashing.

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

* + - 1. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
      2. 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 (150 mm). Install an additional protection mat layer at projections, pipes, vents, and drains, overlapping a minimum of 12 inches (300 mm).

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 roofing ballasted at end of workday.
    2. Roof-Paver Ballast: Install heavyweight roof-paver ballast according to manufacturer's written instructions.
  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 walkway products according to manufacturer's written instructions.
       1. Install flexible walkways at the following locations:

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

* + - * 1. Perimeter of each rooftop unit.
        2. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
        3. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
        4. Top and bottom of each roof access ladder.
        5. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
        6. Locations indicated on Drawings.
        7. As required by roof membrane manufacturer's warranty requirements.
      1. Provide 6-inch (76-mm) clearance between adjoining pads.
      2. 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.
       1. Install roof paver walkways at the following locations:

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

* + - * 1. Perimeter of each rooftop unit.
        2. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.
        3. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.
        4. Top and bottom of each roof access ladder.
        5. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.
        6. Locations indicated on Drawings.
        7. As required by roof membrane manufacturer's warranty requirements.
      1. Provide 3 inches (75 mm) of space between adjacent roof pavers.
  1. FIELD QUALITY CONTROL

Retain "Testing Agency" Paragraph below to identify who shall perform tests and inspections. If retaining second option in "Testing Agency" Paragraph, retain "Field quality-control reports" Paragraph in "Informational Submittals" Article.

* + 1. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Consultant.

If retaining second option in first paragraph below, retain "Field quality-control reports" Paragraph in "Informational Submittals" Article.

* + 1. [Owner will engage a qualified testing agency to perform] [Perform] the following tests:

Retain one or more of six tests below.

Retain "Flood Testing" Subparagraph below if flood testing of roofing system is 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. ASTM D5957 offers guidance on flood testing waterproof membranes, rather than roofing systems, on horizontal surfaces not exceeding 1/4 inch per foot (1:48). If retaining, review procedures in ASTM D5957 for applicability. Note that NRCA does not recommend flood testing.

* + - 1. Flood Testing: Flood test each roofing 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.
         1. Perform tests before overlying construction is placed.
         2. Flood to an average depth of [2-1/2 inches (65 mm)] <**Insert depth**> with a minimum depth of [1 inch (25 mm)] <**Insert depth**> and not exceeding a depth of [4 inches (100 mm)] <**Insert depth**>. Maintain 2 inches (50 mm) of clearance from top of base flashing.

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

* + - * 1. Flood each area for [**24**] [**48**] [**72**] hours.
        2. 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.

* + - * 1. Testing agency shall prepare survey report indicating locations of initial leaks, if any, and final survey report.

Retain "Low-Voltage Electrical Conductance Testing" Subparagraph below if required. First option is for EFVM, which is the most common system. Second option is for platform-type system. Both options identify specific leak locations rather than the presence of entrapped moisture within the roof assembly. See the Evaluations for limitations.

* + - 1. Low-Voltage Electrical Conductance Testing: Testing agency shall survey entire roof area and flashings to locate discontinuity in the roof membrane using [**an exposed metal electrical loop to create an electrical field tested with handheld probes**] [**or**] [**a scanning platform with integral perimeter electrical loops creating a complete electrical field**].
         1. Perform tests before overlying construction is placed.
         2. 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.

* + - * 1. Testing agency shall 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 and inspection agency if preferred.

* + 1. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Consultant, 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, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Consultant and Owner.
     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 coating membrane or 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.

END OF SECTION