

SECTION 07 54 23
THERMOPLASTIC POLYOLEFIN (TPO) ROOFING

SPEC WRITER NOTES:

1. Delete text between // _____ // not applicable to project. Edit remaining text to suit project.
2. Slopes: Do not use on slopes over 1: 12 (one inch per 12 inches). Provide 1: 50 (1/4 inch per 12 inches) minimum to drains without any "Gutters" (no slopes between drains). NO EXCEPTION TO MINIMUM SLOPE. Slope crickets 1: 50 (1/4 inch per foot).
3. Coordinate with plumbing requirements for roof drains and drain locations at low points and mid span where maximum deflection occurs. Do not put drains at columns or on slopes. Coordinate with insulation to provide sumps at drains.
4. Coordinate details and systems used to provide code required fire rated roofing system.
5. Adhered system is preferred over mechanically anchored system.
6. Coordinate with Section 07 22 00, ROOF AND DECK INSULATION.
7. Coordinate with Section 07 22 00, ROOF AND DECK INSULATION for roof insulation under the membrane. Decrease R- value 5 percent when mechanical fasteners are used through insulation to compensate for parallel heat flow.
8. Do not use polystyrene, urethane, or wood fiberboard insulation under membrane.
9. Do not use over bituminous materials where direct contact occurs, including grease, oil, or other substances not compatible with TPO. Use a thin layer of insulation, slip sheet or separator sheet depending upon method of attachment.
10. Terminate base flashings minimum 200 mm (8 inches) above roof surface including curb for building expansion joints.
11. Do not put expansion joints at roof surface level.
12. Do not use "pitch pockets" or "sealant pockets" in lieu of base flashings and cap flashings.
13. This specification is for use over concrete, cellular insulating concrete decks, or insulation. Insert additional text when installed directly to other decks or insulation systems not specified

in Section 07 22 00, ROOF AND DECK
INSULATION.

14. Do not use pipe boots that provide
less than 200 mm (8 inch) height above
roof.

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Thermoplastic Polyolefin (TPO) sheet roofing // adhered //
mechanically fastened // to roof deck.

1.2 RELATED REQUIREMENTS

SPEC WRITER NOTE: Update and retain
references only when specified elsewhere
in this section.

- A. Non-Flooring Adhesives and Sealants VOC Limits: Section 01 81 13,
SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- B. Preparation of Existing Membrane Roofs and Repair Areas: Section
07 01 50.19, PREPARATION FOR REROOFING.
- C. Roof Insulation: Section 07 22 00, ROOF AND DECK INSULATION.

1.3 APPLICABLE PUBLICATIONS

- A. Comply with references to extent specified in this section.
- B. American National Standards Institute/Single-Ply Roofing Institute
(ANSI/SPRI):
 1. FX-1-01(R2006) - Standard Field Test Procedure for Determining the
Withdrawal Resistance of Roofing Fasteners.
- C. American Society of Civil Engineers/Structural Engineering Institute
(ASCE/SEI):
 1. 7-10 - Minimum Design Loads for Buildings and Other Structures.
- D. American Society of Heating, Refrigerating and Air-Conditioning
Engineers, Inc. (ASHRAE):
 1. 90.1-13 - Energy Standard for Buildings Except Low-Rise Residential
Buildings.
- E. ASTM International (ASTM):
 1. C67-14 - Sampling and Testing Brick and Structural Clay Tile.
 2. C140/C140M-15 - Sampling and Testing Concrete Masonry Units and
Related Units.

3. C1371-15 - Determination of Emittance of Materials Near Room Temperature Using Portable Emisometers.
 4. C1549-09(2014) - Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer.
 5. D1876-08(2015)e1 - Peel Resistance of Adhesives (T-Peel Test).
 6. D4263-83(2012) - Indicating Moisture in Concrete by the Plastic Sheet Method.
 7. D4434/D4434M-15 - Poly(Vinyl Chloride) Sheet Roofing.
 8. D6878/D6878M-13 - Thermoplastic Polyolefin Based Sheet Roofing.
 9. E408-13 - Total Normal Emittance of Surfaces Using Inspection-Meter Techniques.
 10. E1918-06(2015) - Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field.
 11. E1980-11 - Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces.
- F. Cool Roof Rating Council (CRRC):
1. 1-15 - Product Rating Program.
- G. National Roofing Contractors Association (NRCA):
1. Manual-15 - The NRCA Roofing Manual: Membrane Roofing Systems.
- H. U.S. Department of Agriculture (USDA):
1. BioPreferred® Program Catalog.
- I. UL LLC (UL):
1. 580-06 - Tests for Uplift Resistance of Roof Assemblies.
 2. 1897-15 - Uplift Tests for Roof Covering Systems.
- J. U.S. Department of Commerce National Institute of Standards and Technology (NIST):
1. DOC PS 1-09 - Structural Plywood.
 2. DOC PS 2-04 - Performance Standard for Wood-Based Structural-Use Panels.
- K. U.S. Environmental Protection Agency (EPA):

SPEC WRITER NOTE: Energy Star Version 2.3
is in effect until June 30, 2017. Version
3.0 becomes effective July 1, 2017.

1. Energy Star - ENERGY STAR Program Requirements for Roof Products
// Version 2.3. // Version 3.0. //

1.4 PREINSTALLATION MEETINGS

- A. Conduct preinstallation meeting at project site minimum 30 days before beginning Work of this section.

SPEC WRITER NOTE: Edit participant list to ensure entities influencing outcome attend.

1. Required Participants:
 - a. Contracting Officer's Representative.
 - b. // Architect/Engineer. //
 - c. // Inspection and Testing Agency. //
 - d. Contractor.
 - e. Installer.
 - f. // Manufacturer's field representative. //
 - g. Other installers responsible for adjacent and intersecting work, including roof deck, flashings, roof penetrations, roof accessories, utility penetrations, rooftop curbs and equipment and // _____ //.

SPEC WRITER NOTE: Edit meeting agenda to incorporate project specific topics.

2. Meeting Agenda: Distribute agenda to participants minimum 3 days before meeting.
 - a. Installation schedule.
 - b. Installation sequence.
 - c. Preparatory work.
 - d. Protection before, during, and after installation.
 - e. Installation.
 - f. Terminations.
 - g. Transitions and connections to other work.
 - h. Inspecting and testing.
 - i. Other items affecting successful completion.
 - j. Pullout test of fasteners.
 - k. Material storage, including roof deck load limitations.
3. Document and distribute meeting minutes to participants to record decisions affecting installation.

1.5 SUBMITTALS

A. Submittal Procedures: Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.

B. Submittal Drawings:

1. Roof membrane layout.

SPEC WRITER NOTE: Retain paragraph below
for mechanically fastened membrane.

2. Roofing membrane fastener pattern and spacing.

3. Roofing membrane seaming and joint details.

4. Roof membrane penetration details.

5. Base flashing and termination details.

6. Paver layout.

7. Paver anchoring locations and details.

C. Manufacturer's Literature and Data:

1. Description of each product.

2. Minimum fastener pullout resistance.

3. Installation instructions.

4. Warranty.

D. Samples:

1. Roofing Membrane: 150 mm (6 inch) square.

2. Base Flashing: 150 mm (6 inch) square.

3. Fasteners: Each type.

4. Roofing Membrane Seam: 300 mm (12 inches) square.

E. Sustainable Construction Submittals:

SPEC WRITER NOTE: Retain sustainable
construction submittals appropriate to
product.

1. Solar Reflectance Index (SRI) for roofing membrane.

2. Biobased Content:

a. Show type and quantity for each product.

3. Low Pollutant-Emitting Materials:

a. Show volatile organic compound types and quantities.

4. Energy Star label for roofing membrane.

F. Certificates: Certify products comply with specifications.

1. Fire and windstorm classification.

SPEC WRITER NOTE: Retain paragraph below for Florida and Gulf coast projects.

- 2. High wind zone design requirements.
- 3. Energy performance requirements.
- G. Qualifications: Substantiate qualifications comply with specifications.
 - 1. Installer, including supervisors with project experience list.
 - 2. Manufacturer's field representative with project experience list.
- H. Field quality control reports.

SPEC WRITER NOTE: Retain paragraph below for reroofing projects.

- I. Temporary protection plan. Include list of proposed temporary materials.
- J. Operation and Maintenance Data:
 - 1. Maintenance instructions.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Approved by roofing system manufacturer as installer for roofing system with specified warranty.
 - 2. Regularly installs specified products.
 - 3. Installed specified products with satisfactory service on five similar installations for minimum five years.
 - a. Project Experience List: Provide contact names and addresses for completed projects.
 - 4. Employs full-time supervisors experienced installing specified system and able to communicate with Contracting Officer's Representative and installer's personnel.
- B. Manufacturer's Field Representative:
 - 1. Manufacturer's full-time technical employee or independent roofing inspector.
 - 2. Individual certified by Roof Consultants Institute as Registered Roof Observer.

1.7 DELIVERY

- A. Deliver products in manufacturer's original sealed packaging.
- B. Mark packaging, legibly. Indicate manufacturer's name or brand, type, and manufacture date.

- C. Before installation, return or dispose of products within distorted, damaged, or opened packaging.

1.8 STORAGE AND HANDLING

- A. Comply with NRCA Manual storage and handling requirements.
- B. Store products indoors in dry, weathertight facility.
- C. Store adhesives according to manufacturer's instructions.
- D. Protect products from damage during handling and construction operations.
- E. Products stored on the roof deck must not cause permanent deck deflection.

1.9 FIELD CONDITIONS

- A. Environment:

SPEC WRITER NOTE: Coordinate installation temperature with available adhesives. Solvent based adhesives can be used at lower temperatures.

- 1. Product Temperature: Minimum 4 degrees C (40 degrees F) for minimum 48 hours before installation.
- 2. Weather Limitations: Install roofing only during dry current and forecasted weather conditions.

1.10 WARRANTY

SPEC WRITER NOTE: Always retain construction warranty. FAR includes Contractor's one year labor and material warranty.

- A. Construction Warranty: FAR clause 52.246-21, "Warranty of Construction."

SPEC WRITER NOTE:
1. Specify extended manufacturer's warranties for materials only.
2. Contracting Officer's Representative must approve specification of a manufacturer's warranty.

- B. Manufacturer's Warranty: Warrant roofing system against material and manufacturing defects and agree to repair any leak caused by a defect in the roofing system materials or workmanship of the installer.

SPEC WRITER NOTE: Specify customarily available warranty period for specified products.

1. Warranty Period: 10 years.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Roofing System: Thermoplastic Polyolefin (TPO) sheet roofing // adhered // mechanically fastened // to roof deck.

2.2 SYSTEM PERFORMANCE

- A. Design roofing system complying with specified performance:
 1. Load Resistance: ASCE/SEI 7; Design criteria as indicated on Drawings.

SPEC WRITER NOTE: Specify actual loads when known for project.

a. Uplift Pressures:

- 1) Corner Uplift Pressure: // _____ // kPa/sq. m
(// _____ // psf).
- 2) Perimeter Uplift Pressure: // _____ // kPa/sq. m
(// _____ // psf).
- 3) Field-of-Roof Uplift Pressure: // _____ // kPa/sq. m
(// _____ // psf).

SPEC WRITER NOTE:

1. Energy performance requirements apply only when white roofing membrane is specified.
2. Retain one or more paragraphs below for compliance with:
 - a. Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings incorporated in Executive Order 13423 "Strengthening Federal Environmental, Energy, and Transportation Management, dated January 24, 2007.
 - b. Energy Policy Act of 2005 (EPAct).
 - c. Energy Independence and Security Act of 2007 (EISA).
 - d. LEED mandate.
 - e. Conformance with locally-applicable requirements.

2. Energy Performance:

SPEC WRITER NOTE: Retain paragraph below for Energy Star compliance.

- a. EPA Energy Star Listed for low-slope roof products.

SPEC WRITER NOTE: Retain paragraph below for LEED heat island effect (roof) credit compliance.

- b. ASTM E1980; Minimum 78 Solar Reflectance Index (SRI).

SPEC WRITER NOTE: Retain paragraph below for California Energy Commission (CEC) Title 24 compliance.

- c. CRRC-1; Minimum 0.70 initial solar reflectance and minimum 0.75 emissivity.

SPEC WRITER NOTE: Typically retain below for VA new construction and reroofing projects in ASHRAE Climate Zones 1 through 3 and elsewhere where cool roof technology is cost-effective.

- d. Three-Year Aged Performance: Minimum 0.55 solar reflectance tested in according to ASTM C1549 or ASTM E1918, and minimum 0.75 thermal emittance tested in according to ASTM C1371 or ASTM E408.

- 1) Where tested aged values are not available:
 - a) Calculate compliance adjusting initial solar reflectance according to ASHRAE 90.1.
 - b) Provide roofing system with minimum 64 three-year aged Solar Reflectance Index calculated according to ASTM E1980 with 12 W/sq. m/degree K (2.1 BTU/h/sq. ft.) convection coefficient.

2.3 PRODUCTS - GENERAL

- A. Provide roof system components from one manufacturer.
- B. Sustainable Construction Requirements:
 - 1. Solar Reflectance Index: 78 minimum.

SPEC WRITER NOTE:
1. Retain paragraph below when complying with Federal Guiding Principles IV from Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings incorporated in Executive Order

13423 "Strengthening Federal Environmental, Energy, and Transportation Management, dated January 24, 2007, Enhance Indoor Environmental Quality - Biobased Content Requirement. Requirement differs from related requirements in LEED definitions.

2. Indicate project goals for percentages of bio-based, rapidly-renewable, and certified sustainable wood products in Section 01 00 00, GENERAL REQUIREMENTS.

2. Biobased Content: Where applicable, provide products designated by USDA and meeting or exceeding USDA recommendations for bio-based content, and products meeting Rapidly Renewable Materials and certified sustainable wood content definitions; refer to www.biopreferred.gov.

SPEC WRITER NOTE:

1. Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS includes comprehensive product list setting VOC limits for low-emitting materials.
2. Retain subparagraphs applicable to products specified in this section.

3. Low Pollutant-Emitting Materials: Comply with VOC limits specified in Section 01 81 13, SUSTAINABLE CONSTRUCTION REQUIREMENTS for the following products:
- a. Non-flooring adhesives and sealants.

2.4 TPO ROOFING MEMBRANE

SPEC WRITER NOTES:

1. Use fabric-backed sheet for adhered systems to cellular insulating concrete, structural concrete, or when re-roofing over other incompatible substrates where the manufacturer recommends a fabric backing for separation.
2. Use sheets without fabric backing when adhering to rigid insulation board cover boards.
3. Do not use TPO sheet in ballasted applications.
4. Use adhered systems over cover boards on new VA construction unless other application is specifically approved by VA.
5. TPO membrane sheet is available in gray and several other colors that will

not meet the DoE cool roof initiative standards.

1. TPO Sheet: ASTM D6878/D6878M, internally fabric or scrim reinforced, 1.5 mm (60 mils) thick, // with no backing // with fabric backing //.

2.5 MEMBRANE ACCESSORY MATERIALS

- A. Sheet Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as TPO sheet membrane.
- B. Factory Formed Flashings: Inside and outside corners, pipe boots, and other special flashing shapes to minimize field fabrication.
- C. Bonding Adhesive: Manufacturer's standard, water based.
- D. Metal Termination Bars: Manufacturer's standard, stainless-steel or aluminum, 25 mm wide by 3 mm thick (1 inch wide by 1/8 inch thick) factory drilled for fasteners.
- E. Battens: Manufacturer's standard, galvanized or galvanized steel sheet, 25 mm wide by 1.3 mm thick (1 inch wide by 0.05 inch thick), factory punched for fasteners.
- F. Fasteners: Manufacturer's standard coated steel with metal or plastic plates, to suit application.
- G. Primers, Sealers, T-Joint Covers, Lap Sealants, and Termination Reglets: As specified by roof membrane manufacturer.
- H. Adhesive and sealant materials recommended by roofing system manufacturer for intended use, identical to materials utilized in approved listed roofing system, and compatible with roofing membrane.

2.6 WALKWAY PADS

- A. Manufacturer's standard, slip-resistant rolls, minimum 900 mm (3 feet) wide by 5 mm (3/16 inch) thick.

2.7 ROOF PAVERS

SPEC WRITER NOTES:

1. Ensure pavers are detailed showing size and shape.
2. Do not exceed 600 mm square (24 inches square) for non-interlocking units with approximate weight of 23 kg (50 pounds) each.
3. Pavers require 73 kg/sq. m (15 lbs./sq. ft.) minimum for fire rating.
4. Interlocking pavers are preferred over non interlocking pavers.
5. Use interlocking type that has been tested in a wind tunnel for wind uplift meeting project requirements.
6. Do not use light weight aggregate pavers.
7. Extensive use of pavers is not appropriate for roof systems with solar reflective design requirements.

- A. Roof Pavers: Precast, normal weight, // interlocking // non-interlocking // concrete units // with ribbed bottom surface for drainage //.
1. Weight: Minimum 73 kg/sq. m (15 lbs./sq. ft.).
 2. Compressive Strength: ASTM C140/C140M; minimum 55 MPa (8,000 psi).
 3. Freeze Thaw: ASTM C67; maximum 1 percent mass loss.
 4. Units of size, shape, and thickness as shown on drawings.

2.8 ACCESSORIES

- A. Temporary Protection Materials:
1. Expanded Polystyrene (EPS) Insulation: ASTM C578.
 2. Plywood: NIST DOC PS 1, Grade CD Exposure 1.
 3. Oriented Strand Board (OSB): NIST DOC PS 2, Exposure 1.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine and verify substrate suitability with roofing Installer and roofing inspector present.

SPEC WRITER NOTE: Require firestopping verification for fire rated roof assemblies.

1. Verify roof penetrations are complete, secured against movement, // and firestopped //.
 2. Verify roof deck is adequately secured to resist wind uplift.
 3. Verify roof deck is clean, dry, and in-plane ready to receive roofing system.
- B. Correct unsatisfactory conditions before beginning roofing work.

3.2 PREPARATION

- A. Complete roof deck construction before beginning roofing work:
1. Curbs, blocking, edge strips, nailers, cants, and other components to which insulation, roofing, and base flashing is attached in place ready to receive insulation and roofing.
 2. Coordinate roofing membrane installation with flashing work and roof insulation work so insulation and flashing are installed concurrently to permit continuous roofing operations.
 3. Complete installation of flashing, insulation, and roofing in same day except for the area where temporary protection is required when work is stopped for inclement weather or end of work day.
- B. Dry out surfaces // including roof deck flutes, // that become wet from any cause during progress of the work before roofing work is resumed. Apply materials to dry substrates, only.
- C. Broom clean roof decks. Remove dust, dirt and debris.
- D. Remove projections capable of damaging roofing materials.
- E. Concrete Decks, except Insulating Concrete:
1. Test concrete decks for moisture according to ASTM D4263 before installing roofing materials.
 2. Prime concrete decks. Keep primer back 100 mm (4 inches) from precast concrete deck joints.
 3. Allow primer to dry before application of bitumen.
- F. Insulating Concrete Decks:
1. Allow to dry out minimum five days after installation before installing roofing materials.
 2. Allow additional drying time when precipitation occurs before installing roofing materials.
- G. Poured Gypsum Decks: Dry out poured gypsum according to manufacturer's instructions before installing roofing materials.

H. Existing Membrane Roofs and Repair Areas:

1. Comply with requirements in Section 07 01 50.19 PREPARATION FOR REROOFING.

3.3 TEMPORARY PROTECTION

- A. Install temporary protection consisting of a temporary seal and water cut-offs at the end of each day's work and when work is halted for an indefinite period or work is stopped when precipitation is imminent.
- B. Install temporary cap flashing over top of base flashings where permanent flashings are not in place to protect against water intrusion into roofing system. Securely anchor in place to prevent blow off and damage by construction activities.
- C. Temporarily seal exposed insulation surfaces within roofing membrane.
 1. Apply temporary seal and water cut off by extending roofing membrane beyond insulation and securely embedding edge of the roofing membrane in 6 mm (1/4 inch) thick by 50 mm (2 inches) wide strip of temporary closure sealant. Weight roofing membrane edge with sandbags, to prevent displacement; space sandbags maximum 2400 mm (8 feet) on center.
 2. Direct water away from work. Provide drainage, preventing water accumulation.
 3. Check daily to ensure temporary seal remains watertight. Reseal open areas and weight down.
- D. Before the work resumes, cut off and discard portions of roof membrane in contact with temporary seal.
 1. Cut minimum 150 mm (6 inches) back from sealed edges and surfaces.
- E. Remove sandbags and store for reuse.

SPEC WRITER NOTE: Use pull out tests for
decks other than wood and wood blocking.

3.4 INSTALLATION - GENERAL

- A. Install products according to manufacturer's instructions and approved submittal drawings.
 1. When manufacturer's instructions deviate from specifications, submit proposed resolution for Contracting Officer's Representative consideration.
- B. Comply with NRCA Manual installation requirements.

SPEC WRITER NOTE: The code requires roof coverings on fully adhered or mechanically fastened non-ballasted roofs to be tested according to UL 580 or UL 1897.

- C. Comply with // UL 580 // UL 1897 // for uplift resistance.
- D. Do not allow membrane and flashing to contact surfaces contaminated with asphalt, coal tar, oil, grease, or other substances incompatible with TPO.

3.5 ROOFING INSTALLATION

- A. Install the membrane so the sheets run perpendicular to the long dimension of the insulation boards.
- B. Begin installation at the low point of the roof and work towards the high point. Lap membrane shingled in water flow direction.
- C. Position the membrane free of buckles and wrinkles.
- D. Roll membrane out; inspect for defects as membrane is unrolled. Remove defective areas:
 - 1. Lap edges and ends of sheets 50 mm (2 inches) or more as recommended by the manufacturer.
 - 2. Heat weld laps. Apply pressure as required. Seam strength of laps as required by ASTM D4434/D4434M.
 - 3. Check seams to ensure continuous adhesion and correct defects.
 - 4. Finish seam edges with beveled bead of lap sealant.
 - 5. Finish seams same day as membrane is installed.
 - 6. Anchor membrane perimeter to roof deck or parapet wall as indicated on drawings.
 - 7. Repair areas of welded seams where samples have been taken or marginal welds, bond voids, or skips occurs.
 - 8. Repair fishmouths and wrinkles by cutting to lay flat and installing patch over cut area extending 100 mm (4 inches) beyond cut.
- E. Membrane Perimeter Anchorage:
 - 1. Install batten at perimeter of each roof area, curb flashing, expansion joints and similar penetrations on top of roof membrane as indicated on drawings.
 - 2. Mechanically Fastening:
 - a. Space fasteners maximum 300 mm (12 inches) on center, starting 25 mm (1 inch) from ends.
 - b. When battens are cut, round edges and corners before installing.

- c. After mechanically fastening strip cover and seal strip with a 150 mm (6 inch) wide roof membrane strip; heat weld to roof membrane and seal edges.
- d. At // gravel stops // fascia-cants // turn roofing membrane down over front edge of the blocking, cant, or nailer. Secure roofing membrane to vertical portion of nailer; or, if required by the membrane manufacturer, with fasteners spaced maximum 150 mm (6 inches) on centers.
- e. At parapet walls intersecting building walls and curbs, secure roofing membrane to structural deck with fasteners 150 mm (6 inches) on centers or as shown in NRCA manual.

F. Adhered System:

- 1. Apply bonding adhesive in quantities required by roof membrane manufacturer.
- 2. Fold sheet back on itself, clean and coat the bottom side of the membrane and the top of substrate with adhesive. Do not coat the lap joint area.
- 3. After adhesive has set according to adhesive manufacturer's instruction, roll roofing membrane into adhesive minimizing voids and wrinkles.
- 4. Repeat for other half of sheet.

G. Mechanically Fastened System Installation:

- 1. Secure roofing membrane to structural deck with fasteners through battens to achieve specified wind uplift performance.
 - a. Drill pilot holes for fasteners installed into cast-in-place concrete. Drill hole minimum 10 mm (3/8 inch) deeper than fastener penetration.
- 2. When fasteners are installed within membrane laps, locate battens minimum 13 mm (1/2 inch) from the edge of sheets.
- 3. Apply lap sealant under battens and anchor to deck while lap sealant is still fluid. Cover fastener head with fastener sealer.
- 4. Where fasteners are installed over roofing membrane after seams are welded, cover fasteners with minimum 200 mm (8 inch) diameter TPO membrane cap centered over fasteners. Where battens are used cover battens with minimum 200 mm (8 inch) wide TPO strip cap centered over batten. Splice caps to roofing membrane and finish edges with lap sealant.

3.6 FLASHING INSTALLATION

- A. Install flashings same day as roofing membrane is installed. When flashing cannot be completely installed in one day, complete installation until flashing is watertight and provide temporary covers or seals.

SPEC WRITER NOTES:

1. Ensure roof drain flashing details are shown on drawings with sump to depress notched clamping ring below roof surface.
2. Offset drains in sump to side of steel beams so drain is not above low point when roof slope terminates on top of beam.

B. Flashing Roof Drains:

1. Install roof drain flashing as recommended by roofing membrane manufacturer.
 - a. Coordinate to set the metal drain flashing in asphalt roof cement, holding cement back from the edge of the metal flange.
 - b. Do not allow the roof cement to come in contact with TPO roofing membrane.
 - c. Adhere roofing membrane to metal flashing with bonding adhesive.
2. Turn down the metal drain flashing and roofing membrane into drain body. Install clamping ring and strainer.

SPEC WRITER NOTES:

1. See NRCA manual for base flashing details.
2. Use with metal cap flashing.
3. Do not use "pitch pocket" or "sealant pocket" construction detail.
4. Coordinate with sheet metal work to provide metal cap flashing for base flashing on curbs and walls and penetrations.
5. Do not terminate base flashing or membrane edge exposed on top of parapet walls or in reglets on horizontal or sloped wash surface.
6. Terminate only under cap flashings or coping covers except for draw bands on pipe boots and gravel stops.
8. Use 200 mm (8 inch) minimum height for base flashing.

C. Installing Base Flashing and Pipe Flashing:

1. Install flashing sheet to pipes, wall or curbs to minimum 200 mm (8 inches) above roof surfaces and extending roofing manufacturer's standard lap dimension onto roofing membranes.
 - a. Adhere flashing with bonding adhesive.
 - b. Form inside and outside corners of flashing sheet according to NRCA manual. Form pipe flashing according to NRCA manual.
 - c. Lap ends roofing manufacturer's standard dimension.
 - d. Heat weld flashing membranes together and flashing membranes to roofing membranes. Finish exposed edges with lap sealant.
 - e. Install flashing membranes according to NRCA manual.
 2. Anchor top of flashing to walls and curbs with fasteners spaced maximum 150 mm (6 inches) on center. Use surface mounted fastening strip with sealant on ducts. Use pipe clamps on pipes or other round penetrations.
 3. Apply sealant to top edge of flashing.
- D. Installing Building Expansion Joints:

SPEC WRITER NOTES:

1. Do not put expansion joints at roof membrane level.
2. Design joints to be installed on curbs minimum 200 mm (8 inches) high.
3. Detail expansion joint.

1. Install base flashing on curbs as specified.
 2. Coordinate installation with // metal expansion joint cover // roof expansion joint system //.
 3. Install flexible tubing 1-1/2 times the width of joint centered over joint. Cover tubing with flashing sheet adhered to base flashing and lapping base flashing roofing manufacturer's standard dimension. Finish edges of laps with sealant.
- E. Repairs to Membrane and Flashings:
1. Remove sections of roofing membrane or flashing that are creased, wrinkled, or fishmouthed.
 2. Cover removed areas, cuts and damaged areas with a patch extending 100 mm (4 inches) beyond damaged, cut, or removed area. Heat weld to roofing membrane or flashing sheet. Finish edge of lap with lap sealant.

3.7 WALKWAY PAD INSTALLATION

- A. Heat weld walkway sheet to roofing membrane at edges. Weld area 50 mm (2 inches) wide by the entire length of the walkway sheet.
- B. Finish edges of laps with lap sealant.

3.8 PAVER INSTALLATION

SPEC WRITER NOTES:

1. Use pavers in the following locations as a minimum:
 - a. At working and access areas of equipment requiring servicing.
 - b. At equipment having discharges detrimental to roof membrane, under gooseneck discharges from kitchens and chemical exhausts.
 - c. At landing points for hatches, ladders, and doors entering roof level.
2. Confirm walkways and pavers are shown on drawings.
3. Pavers:
 - a. Pavers without interlocking connectors require strapping together and edge clamps when pavers do not provide minimum weight for wind uplift resistance.
 - b. Use mechanical strapping to create perimeter anchor, at penetrations, cuts at valleys, over drains, and where partial or cut units occur.
 - c. Detail strapping, perimeter restraints, edge clamps and location of strapping. Do not anchor through base flashing or into cants.
4. Interlocking connectors:
 - a. Use 400 mm (16 inches) on center minimum spacing of connectors.
 - b. Decrease spacing to 300, 200, or 100 mm (12, 8, or 4 inches) on center for greater wind velocities.

- A. Install pavers as soon as roofing membrane is installed.
 1. Saw cut or core drill pavers for cut units.
 2. Install pavers with butt joints in running bond with minimum one half-length units at ends.
 - a. Stagger end joints; generally locate joints near midpoint of adjacent rows, except where end joints occur in valleys. Miter end joints to fit in valleys.
 - b. Cut to fit within 13 mm (1/2 inch) of penetrations.
 3. Install interlocking connectors in channel units for complete tie in of units, including cut units. Use corner spacings for a distance of

1200 mm (4 feet) or more around roof drains, penetrations, and other vertical surfaces in the field of the roof area.

- a. Space connectors at // _____ // mm (// _____ // inches) on center at the corners for 3 m (10 foot) square area.
 - b. Space connectors at // _____ // mm (// _____ // inches) on center at the perimeter for 1800 mm (6 foot) wide strip.
 - c. Space connectors at // _____ // mm (// _____ // inches) on center in the field.
 - d. Install pavers under the perimeter retainer as shown on drawings.
4. Install strapping where shown.
- a. Limit strap lengths to a maximum of 9 m (30 feet).
 - b. Install straps at corner connection to the perimeter retainer at approximate 45 degree angle at approximate 3 to 3.6 m (10 to 12 feet) from corner.
 - c. Install straps on both sides of valleys, hips, and ridges, with cross straps spaced maximum 1200 mm (4 feet) on center between end straps.
 - d. Install straps at the perimeter of penetrations more than two pavers in width or length.
 - e. Anchor straps to each paver with two fasteners per unit.
 - f. Pre-drill holes for fasteners in pavers.

3.9 FIELD QUALITY CONTROL

SPEC WRITER NOTE: Section 01 45 29, TESTING LABORATORY SERVICES includes VA provided testing for large projects and contractor provided testing for small projects. Coordinate testing responsibility.

- A. Field Tests: Performed by testing laboratory specified in Section 01 45 29, TESTING LABORATORY SERVICES.

SPEC WRITER NOTE: ANSI/SPRI FX-1 sets testing frequency as 10 tests for first 4,650 sq. m (50,000 sq. ft.) and five tests for each additional 4,650 sq. m (50,000 sq. ft.). Specify frequency to suit project conditions.

1. Fastener Pull Out Tests: ANSI/SPRI FX-1; one test for every 230 sq. m (2,500 sq. ft.) of deck. Perform tests for each

combination of fastener type and roof deck type before installing roof insulation.

- a. Test at locations selected by Contracting Officer's Representative.
 - b. Do not proceed with roofing work when pull out resistance is less than manufacturer's required resistance.
 - c. Test Results:
 - 1) Repeat tests using different fastener type or use additional fasteners achieve pull out resistance required to meet specified wind uplift performance.
 - 2) Patch cementitious deck to repair areas of fastener tests holes.
 2. Examine and probe roofing membrane and flashing seams in presence of Contracting Officer's Representative and Manufacturer's field representative.
 3. Probe seams to detect marginal bonds, voids, skips, and fishmouths.
 4. Cut 100 mm (4 inch) wide by 300 mm (12 inch) long samples through seams where directed by Contracting Officer's Representative.
 5. Cut one sample for every 450 m (1500 feet) of seams.
 6. Cut samples perpendicular to seams.
 7. Failure of samples to pass ASTM D1876 test will be cause for rejection of work.
 8. Repair areas where samples are taken and where marginal bond, voids, and skips occur.
 9. Repair fishmouths and wrinkles by cutting to lay flat. Install patch over cut area extending 100 mm (4 inches) beyond cut.
- B. Manufacturer Services:
1. Inspect initial installation, installation in progress, and completed work.
 2. Issue supplemental installation instructions necessitated by field conditions.
 3. Prepare and submit inspection reports.
 4. Certify completed installation complies with manufacturer's instructions and warranty requirements.

3.10 CLEANING

- A. Remove excess adhesive before adhesive sets.
- B. Clean exposed roofing surfaces. Remove contaminants and stains // to comply with specified solar reflectance performance //.

3.11 PROTECTION

- A. Protect roofing system from traffic and construction operations.
 - 1. Protect roofing system when used for subsequent work platform, materials storage, or staging.
 - 2. Distribute scaffolding loads to exert maximum 50 percent roofing system materials compressive strength.
- B. Loose lay temporary insulation board overlaid with plywood or OSB.
 - 1. Weight boards to secure against wind uplift.
- C. Remove protective materials immediately before acceptance.
- D. Repair damage.

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