SECTION 07 53 23
ETHYLENE-PROPYLENE-DIENE-MONOMER ROOFING

SPEC WRITER NOTES:
1. Delete between //______// if not applicable to project. Also delete any other item or paragraph not applicable in the section and renumber the paragraphs.

2. Slopes: Do not use on slopes over 1:10 (one inch per foot). Provide 1:50 (1/4 inch per foot) minimum to drains without any "Gutters" (no slopes between drains). Slope crickets 1:50 (1/4-inch per foot). NO EXCEPTION TO MINIMUM SLOPE.

3. Coordinate with plumbing requirements for roof drains and drain locations at low points and mid span where maximum deflection occurs. Do not put drain at columns or on slopes. Coordinate with insulation to provide "dishes" at drains.

4. Coordinate details and systems used to provide code required fire rated roofing system. Do not use unsurfaced membranes over combustible insulation on decks.

5. Use of adhered system is preferred over mechanically anchored or a ballasted system.

6. When a ballasted system is used:
   a. Coordinate to insure structural design provides for square foot dead load of ballast for aggregate and paving units. Do not use on an existing structure where the structural system will not take the ballast dead load.
   b. Design for wind uplift at site.
   c. Select rate of ballast in accordance with FM Data Sheets 1-7, 1-28, and Technical Advisory Bulletin (TAB) 1-29.
   d. Use pavers or loose aggregate or both over membrane.
   e. Coordinate details to provide raised roof edge 200 mm (8 inches) minimum above surface of aggregate ballast or clamping device for pavers at edge and strapping where necessary when parapet walls over 600 mm (24 inches) high do not occur.
   f. Do not use over loose laid 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 the insulation to compensate for parallel heat flow.
8. Do not use over polystyrene, urethane, or wood fiberboard insulation under the membrane.
9. Do not use over bituminous materials where direct contact occurs, including grease, oil, or other substances not compatible with EPDM. Use a thin layer of insulation, slip sheet or separator sheet depending upon method of attachment.
10. Terminate base flashings not less than 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 pocket" or "sealant pocket" in lieu of base flashings and cap flashings.
13. This specification is for use over cellular insulating concrete decks, 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 do not provide less than 100 mm (4 inch) height above roof.

PART 1 GENERAL

1.1 DESCRIPTION

A. Ethylene Propylene Diene Monomer (EPDM) sheet roofing // adhered // mechanically fastened // ballasted // to roof deck.
B. Fire rated roof system.

1.2 RELATED WORK

A. Treated wood framing, blocking, and nailers: Section 06 10 00, ROUGH CARPENTRY.
B. Roof Insulation: Section 07 22 00, ROOF AND DECK INSULATION.
C. Metal cap flashings, copings, fascias, and expansion joints: Section 07 60 00, FLASHING AND SHEET METAL.
D. Roof hatches, equipment supports, dome type skylights, and gravity ventilators: Section 07 72 00, ROOF ACCESORIES.
E. Mechanical equipment supports: Section 23 34 00, HVAC FANS and Section 23 31 00, HVAC DUCTS AND CASINGS, Section 23 37 00, AIR OUTLETS AND INLETS.

1.3 QUALITY ASSURANCE

A. Approved applicator by the membrane roofing system manufacturer, and certified by the manufacturer as having the necessary expertise to install the specific system.
B. Pre-Roofing Meeting:
   1. Upon completion of roof deck installation and prior to any roofing application, hold a pre-roofing meeting arranged by the Contractor and attended by the Roofing Inspector, Material Manufacturers Technical Representative, Roofing Applicator, Contractor, and Resident Engineer,
   2. Discuss specific expectations and responsibilities, construction procedures, specification requirements, application, environmental conditions, job and surface readiness, material storage, and protection.
   3. Inspect roof deck at this time to:
      a. Verify that work of other trades which penetrates roof deck is completed.
      b. Determine adequacy of deck anchorage, presence of foreign material, moisture and unlevel surfaces, or other conditions that would prevent application of roofing system from commencing or cause a roof failure.
      c. Examine samples and installation instructions of manufacturer.
      d. Perform pull out test of fasteners (See paragraph 3.2).

1.4 SUBMITTALS
   A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES.
   B. Applicators approval certification by manufacturer.
   C. Shop Drawings:
      1. Sheet membrane layout.
      2. Fastener pattern, layout, and spacing requirements.
      3. Termination details.
   D. Manufacturers installation instructions revised for project.
   E. Samples:
      1. Sheet membrane: One 150 mm (6 inch) square piece.
      2. Sheet flashing: One 150 mm (6 inch) square piece.
      3. Fasteners: Two, each type.
      4. Welded seam: Two 300 mm (12 inch) square samples of welded seams to represent quality of field welded seams.

1.5 DELIVERY, STORAGE AND HANDLING
   A. Deliver, store, and handle materials as specified by manufacturer.
   B. Store volatile materials separate from other materials with separation to prevent fire from damaging the work, or other materials.
1.6 WARRANTY

Roofing work subject to the terms of the Article “Warranty of Construction”, FAR clause 52.246-21, except extend the warranty period to five years.

1.7 APPLICABLE PUBLICATIONS

A. Publications listed below form a part of this specification to the extent referenced. Publications are referenced in the text by the basic designation only.

B. American Society for Testing and Materials (ASTM):
   A167-99(R2009) ........ Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
   B209-07 ............... Aluminum and Aluminum-Alloy Sheet and Plate
   D751-06 ................. Coated Fabrics
   D2103-10 .............. Polyethylene Film and Sheeting
   D2240-05(R2010) ......... Rubber Property - Durometer Hardness
   D3884-09 .............. Abrasive Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)
   D4637-10 .............. EPDM Sheet Used in Single-Ply Roof Membrane
   D4586-07 .............. Asphalt Roof Cement, Asbestos Free
   E96-10 ................ Water Vapor Transmission of Materials
   E108-10 ................ Fire Tests of Roof Coverings
   G21-09 ................. Resistance of Synthetic Polymeric Materials to Fungi

C. National Roofing Contractors Association (NRCA):

D. Federal Specifications (Fed. Spec.)
   FF-S-107C(2) ............ Screws, Tapping and Drive
   FF-S-111D(1) ............ Screw, Wood
   UU-B-790A ............... Building Paper, Vegetable Fiber (Kraft, Waterproofed, Water Repellent and Fire Resistant)

E. Factory Mutual Engineering and Research Corporation (FM):
   Annual Issue ............ Approval Guide Building Materials

F. Underwriters Laboratories, Inc (UL):
   Annual Issue ............ Building Materials Directory
   Annual Issue ............ Fire Resistance Directory

G. Warnock Hersey (WH):
   Annual Issue ............ Certification Listings
PART 2 - PRODUCTS

SPEC WRITER NOTES:
1. Make material requirements agree with applicable requirements specified in the referenced Applicable Publications.
2. Update and specify only that which applies to the project.
3. Use of 1.14 mm (0.045-inch) thick sheet is permitted for ballasted system or fully adhered system.
4. Use 1.5 mm (0.060-inch) thick reinforced membrane for mechanically attached system.
5. Use fire retardant membrane when not protected by ballast or pavers. Verify for FM, UL, or WH approval.

2.1 EPDM SHEET ROOFING
A. Conform to ASTM D4637, Type I, Grade 1, // black color // white color //, gray color //.
B. Additional Properties:

<table>
<thead>
<tr>
<th>PROPERTY</th>
<th>TEST METHOD</th>
<th>REQUIREMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shore A Hardness</td>
<td>ASTM D2240</td>
<td>55 to 75 Durometer</td>
</tr>
<tr>
<td>Water Vapor Permeance</td>
<td>ASTM E96</td>
<td>Minimum 0.14 perms Water Method</td>
</tr>
<tr>
<td>Fungi Resistance</td>
<td>ASTM G21</td>
<td>After 21 days, no sustained growth or discoloration.</td>
</tr>
<tr>
<td>Fire Resistance</td>
<td>ASTM E108</td>
<td>Class A</td>
</tr>
<tr>
<td></td>
<td>Class A</td>
<td>No Combustion Beyond Flame/Heat Source</td>
</tr>
</tbody>
</table>

C. Thickness:
1. Use 1.14 mm (0.045-inch) thick sheet for adhered system // ballasted system //.
2. Use 1.5 mm (0.060-inch) thick sheet for mechanically anchored system.

D. Pipe Boots:
1. Molded EDPM designed for flashing of round penetrations, 200 mm (8 inch) minimum height.
2. Color same as roof membrane.

2.2 EPDM FLASHING SHEET
A. Conform to ASTM D4637, Type I, Grade 1, Class U, unreinforced, color, same as roof membrane modified as specified for flashing.
B. Self curing EPDM flashing, adaptable to irregular shapes and surfaces.
C. Minimum thickness 1.5 mm (0.060-inch).

2.3 MISCELLANEOUS ROOFING MEMBRANE MATERIALS
A. Sheet roofing manufacturers specified products.
B. Splice Adhesive: For roofing and flashing sheet.
C. Lap Sealant: Liquid EPDM rubber for roofing sheet exposed lap edge.
D. Bonding Adhesives: Neoprene, compatible with roofing membrane, flashing membrane, insulation, metals, concrete, and masonry for bonding roofing and flashing sheet to substrate.
E. Fastener Sealer: One part elastomeric adhesive sealant.
F. Temporary Closure Sealers (Night Sealant): Polyurethane two part sealer.
G. Primers, Splice Tapes, Cleaners, and Butyl Rubber Seals: As specified by roof membrane manufacturer.

2.4 FASTENERS
A. Fasteners and washers required for securing sheet roofing to deck:
   1. Steel stress plate washers as required by sheet roofing manufacturer:
      a. Coated against corrosion.
      b. Separate or attached to fastener.
      c. Approximately 50 mm (2 inch) diameter or 40 mm x 65 mm (1-1/2 by 2-1/2 inches) rectangular plate with rounded corners, minimum thickness 0.6 mm (0.023-inch).
   2. Fastening strip or batten strip for securing roof membrane to deck:
      a. Stainless steel strip: ASTM A167 type 302 or 304, minimum 0.5 mm (0.018-inch) thick.
      b. Aluminum strip: ASTM B209, minimum 2.4 mm (0.094-inch) thick.
      c. Rounded corners on strips.
      d. Form strips 38 mm (1-1/2 inches) wide, 3000 mm (10 feet) maximum length with 6 mm x 10 mm (1/4 by 3/8 inch) punched slotted holes at 100 mm (4 inch) centers; centered on width of strip. Punch holes 2 mm (1/16 inch) larger than fastener shank when shank is larger than 5 mm (3/16 inch).
   3. Steel decks: Screws; Fed Spec FF-S-107, hardened nylon screw or steel screw coated to resist corrosion, self drilling, anti-backout thread design. Minimum pullout resistance of 135 Kg (300 pounds), minimum thread penetration of 13 mm (1/2 inch).
   4. Gypsum, Insulating Concrete, and Structural Cement Fiber Decks: Diverging or hooking point fastener, anti-spin fitting; or specifically designed for anchorage to deck as recommended by roofing membrane manufacturer, coated to resist corrosion, minimum pullout resistance of 200 Kg (450 pounds).
   5. Concrete and Masonry Wall Surfaces:
      a. Nail penetration 13 mm (1/2 inch).
   6. Wood:
      a. Screws; Fed. Spec. FF-S-111, Type I, Style 2.5, coated to resist corrosion, length to provide 19 mm (3/4 inch) minimum penetration.
7. Washers: Neoprene backed metal washer 28 mm (1-1/8 inch) minimum diameter.
8. To Sheet Metal: Self tapping screw; Fed. Spec. FF-S-107, 2 mm (No. 14), sheet metal screw, minimum thread penetration of 6 mm (1/4 inch); stainless steel.

B. Pipe Compression Clamp or Drawband:
1. Stainless steel or cadmium plated steel drawband.
2. Worm drive clamp device.

C. Surface mounted base flashing clamp strip:
1. Stainless steel strip, ASTM A167, type 302 or 304, dead soft temper, minimum 0.5 mm (0.018-inch) thick.
2. Aluminum strip: ASTM B209 24 mm (.094-inch) thick.
3. For exposed location, form strips with 6 mm (1/4 inch) wide top edge bent out 45 degrees (for sealant) from 40 mm (1-1/2 inch) wide material; 2400 mm (8 feet) maximum length with slotted 6 mm x 10 mm (1/4 by 3/8-inch) holes punched at 200 mm (8 inch) centers, centered between bend and bottom edges.
4. For locations covered by cap flashings, form strips 30 mm (1-1/4 inch) wide, 2400 mm (8 feet) maximum length with slotted holes 6 mm x 10 mm (1/4 by 3/8 inch) punched at 200 mm (8 inch) centers, centered on strip width.

D. Fasteners and washers required for securing pavers together with straps and to walls or other anchorage.
1. Straps for securing pavers together:
   a. Stainless steel strap: ASTM A167, type 302 or 304, minimum 0.46 mm (0.018 inch) thick.
   b. Aluminum strap: ASTM B209, minimum 2.39 mm (0.094 inch) thick.
   c. Rounded corners on straps.
   d. Form straps 38 mm 91-1/2 inches) wide, 3 m (10 feet) maximum length with 6 by 10 mm (1/4 by 3/8 inch) punched slotted holes at 100 mm (4 inch centers centered on width of strap. Punch hole size 2 mm (1/16 inch) larger than fastener shank when shank is thicker than 5 mm (3/16 inch).

E. Fasteners or Connectors for Pavers:
1. For NCMA Roofcap Pavers extruded interlocking hollow shape polyethylene connector:
   a. Material shall conform to ASTM D1248, Type 1, low density, Class C, black weather resistant, Grade E6, tensile strength 15 Mpa (2200 psi), shore D hardness of 4, brittleness low temperature -82°C (180°F), softening temperature above 80°C (176°F).
b. Length: 50 mm (2 inches), with center stop and insert leg with ribs to resist withdrawal; minimum 1.3 mm (0.05 inch) thick.

2. Fasteners for pavers straps:
   a. Stainless steel as recommended by manufacturer of paver in which fastener is anchored.
   b. Fasteners that are not acceptable include:
      1) Impact or power actuated fasteners.
      2) Fasteners that do not require a predrilled pilot hole.
      3) Fasteners with lead or white metal anchors.
      4) Plastic anchors not stabilized against ultraviolet light.

SPEC WRITER NOTES: Use of a protection mat or separator sheet is required under ballast.

2.5 VAPOR RETARDER OR SEPARATION SHEETS
   A. Polyethylene film: ASTM D2103, 0.2 mm (6 mils) thick.
      1. Water vapor resistance: Type I, Grade A, Style 4, reinforced.
      2. Water vapor permeable: Type I, Grade D, Style 4, reinforced.

2.6 FLEXIBLE TUBING
   A. Closed cell neoprene, butyl polyethylene, vinyl, or polyethylene tube or rod.
   B. Diameter approximately 1-1/2 times joint width.

2.7 WALKWAY PADS
   A. Rubber walkway pad approximately 450 mm x 450 mm (30 by 30 inches) square or manufacturers standard size with rounded corners.
   B. Approximately 13 mm (1/2 inch) thick.
   C. Ultraviolet light stabilized.

2.8 PROTECTION MAT OR SEPARATION SHEETS
   A. Protection Mat:
      1. Water pervious; either woven or non-woven pervious sheet of long chain polymeric filaments or yarns such as polypropylene, black polyethylene, polyester, or polyamide; or, polyvinylidene-chloride formed into a pattern with distinct and measurable openings.
      2. Filter fabric equivalent opening size (EOS): Not finer than the U.S.A. Standard Sieve Number 120 and not coarser than the U.S.A. Standard Sieve Number 100. EOS is defined as the number of the U.S.A. Standard Sieve having openings closest in size to the filter cloth openings.
      3. Edges of fabric selvaged or otherwise finished to prevent raveling.
4. Abrasion resistance:
   a. After being abraded in conformance with ASTM D3884 using rubber-hose abrasive wheels with one kg load per wheel and 1000 revolutions, perform tensile strength test as specified in ASTM D1682, paragraph.
   b. Result; 25 kg (55 pounds) minimum in any principle direction.
5. Puncture strength:
   a. ASTM D751 - tension testing machine with ring clamp; steel ball replaced with a 8 mm (5/16 inch) diameter solid steel cylinder with a hemispherical tip centered within the ring clamp.
   b. Result; 57 kg (125 pounds) minimum.
6. Non-degrading under a wet or humid condition within minimum 4°C (40°F) to maximum 66°C (150°F) when exposed to ultraviolet light.
7. Minimum sheet width: 2400 mm (8 feet).

**SPEC WRITER NOTES:**
1. When roof membrane is anchored to substrate and left exposed specify and show pavers around equipment requiring servicing for protection of membrane.
2. Use pavers for walkways and around equipment requiring servicing when aggregate ballast is used.
3. Pavers are preferred over aggregate ballast, or a combination of pavers and aggregate, over aggregate only.
4. Check ballast and paver weights required for Fire Rated system.
5. Use only pavers when I90 wind loads occur.

### 2.9 BALLAST AND PAVERS

**A. Aggregate:**
1. Conform to ASTM D1863.
2. Gradation conform to ASTM D448:
   a. Size 2 for 146 kg/m² (30 pounds per square foot) or more.
   b. Size 3 for 122 kg/m² (25 pounds per square foot) or more.
   c. Size 5 for 73 kg/m² (15 pounds per square foot) or more.
   d. Size 6 for 49 kg/m² (10 pounds per square foot) or more.

**SPEC WRITER NOTE:**
1. Assure 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/m² (15 pounds per square foot) minimum for fire rating.
4. Interlocking pavers are preferred over non-interlocking pavers.
5. Use interlocking type that have been tested in a wind tunnel for wind uplift.
6. Do not use light weight aggregate pavers.

B. Pavers:
1. Weighing not less than 73 kg/m² (15 pounds per square foot).
2. Non-Interlocking Concrete Masonry Unit Pavers: ASTM C90, Grade N 1.
   a. Manufactured using normal weight aggregate.
   b. Units of size, shape, and thickness as shown.
   c. Ribbed on bottom surface or provided with legs approximately 6 mm (1/4 inch) high. Legs to distribute weight of paver so bearing does not exceed 69 kPa (10 psi) on the roofing membrane.
3. Interlocking Concrete Paving Units:
   a. Manufactured using normal weight aggregate.

PART 3 - EXECUTION
3.1 GENERAL
A. Do not apply if deck will be used for subsequent work platform, storage of materials, or staging or scaffolding will be erected thereon unless protection provided to distribute loads less than one-half compression resistance of roofing system materials.
1. Curbs, blocking, edge strips, and other components to which roofing and base flashing is attached in place ready to receive insulation and roofing.
2. Coordinate roof operation with sheet metal work and roof insulation work so that insulation and flashing are installed concurrently to permit continuous roofing operations.
3. Complete installation of flashing, insulation, and roofing in the same day except for the area where temporary protection is required when work is stopped.
B. Phased construction is not permitted. The complete installation of roofing system is required in the same day except for area where temporary protection is required when work is stopped. Complete installation includes pavers and ballast for ballasted systems.
C. Dry out surfaces //, including the flutes of metal deck, // that become wet from any cause during progress of the work before roofing work is resumed.
D. Apply materials only to dry substrates.
E. Except for temporary protection specified, do not apply materials during damp or rainy weather, during excessive wind conditions, nor while moisture (dew, snow, fog, ice, or frost) is present in any amount in or on the materials.
1. Do not apply materials to substrate having temperature of 4°C (40 degrees F) or less, or when materials applied with the roof require higher application temperature.
2. Do not apply materials when the temperature is below 4°C (40 degrees F).

F. Temporary Protection:
1. 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.
2. Temporarily seal exposed surfaces of insulation within the roofing membrane.
3. Do not leave insulation surfaces or edges exposed.
4. Use polyethylene film or building paper to separate roof sheet from bituminous materials.
5. Apply the temporary seal and water cut off by extending the roof membrane beyond the insulation and securely embedding the edge of the roof membrane in 6 mm (1/4 inch) thick by 50 mm (2 inches) wide strip of temporary closure sealant (night sealant) and weight edge with sandbags, to prevent displacement; space sandbags not over 2400 mm (8 foot) centers. Check daily to insure temporary seal remains watertight. Reseal open areas and weight down.
6. Before the work resumes, cut off and discard portions of the roof membrane in contact with roof cement or bituminous materials.
   a. Cut not less than 150 mm (6 inches) back from bituminous coated edges or surfaces.
   b. Remove temporary polyethylene film or building paper.
7. Remove and discard sandbags contaminated with bituminous products.
8. For roof areas that are to remain intact and that are subject to foot traffic and damage, provide temporary wood walkways with notches in sleepers to permit free drainage.
9. Provide 2 mm (6 mil) polyethylene sheeting or building paper cover over roofing membrane under temporary wood walkways and adjacent areas. Round all edges and corners of wood bearing on roof surface.

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

3.2 PREPARATION

//A. Test pull out resistance of fasteners in deck in the presence of the Resident Engineer before starting roofing work. Tests are not required for wood.
1. Test applicable fastener type in applicable deck.
2. Install fasteners through a sample of the insulation, if any is to be used, into the structural deck.
3. Test the pull out resistance with a pull out tester.
4. Test one fastener in each deck level and one for every 230 m² (2500 square feet) of deck type and level.
5. Test at locations designated by Resident Engineer.
6. Do not proceed with the roofing work if the pull out resistance of the fasteners is less than specified.
7. Test results:
   a. Repeat tests using other type fasteners or use additional fasteners to stay within the pullout load resistance criteria.
   b. Patch cementitious deck to repair areas of fastener tests holes.

B. Remove dirt, debris, and surface moisture. Cover or fill voids greater than 6 mm (1/4 inch) wide to provide solid support for roof membrane.
C. Install separation sheet over bituminous material on deck surface lapping edges and ends 150 mm (6 inches) or as recommended by roof membrane manufacturer.
   1. Do not install of separation sheet beyond what can be covered by roofing membrane each day.
   2. Use polyethylene, or building paper, that will be compatible with seaming method.
   3. Insure separation sheet completely isolates bituminous materials from EPDM roofing membrane.
   4. Turn up at penetrations, or other surfaces where bituminous materials occur, to cover bituminous product.
   5. Turn down over edges of blocking at perimeters to cover blocking.

3.3 INSTALLATION OF ROOFING AND FLASHING
A. Do not allow the membrane to come in contact with surfaces contaminated with asphalt, coal tar, oil, grease, or other substances which are not compatible with EPDM roofing membrane.
B. If possible, install the membrane so the sheets run perpendicular to the long dimension of the insulation boards.
C. If possible, start at the low point of the roof and work towards the high point. Lap the sheets so the flow of water is not against the edges of the sheet. // Start at high point of metal decks without insulation.// Coordinate with roof insulation installation.
D. Position the membrane so it is free of buckles and wrinkles.
E. Roll sheet out on deck; inspect for defects as sheet is being rolled out and remove defective areas:
   1. Allow 30 minutes for relaxing before proceeding.
2. Lap edges and ends of sheets 75 mm (3 inches) or more as recommended by the manufacturer. Clean lap surfaces as specified by manufacturer.
3. Adhesively splice laps. Apply pressure as required. Seam strength of laps as required by ASTM D4637.
4. Check seams to ensure continuous adhesion and correct defects.
5. Finish edges of laps with a continuous beveled bead of lap sealant to sheet edges to provide smooth transition as specified by manufacturer.
6. Finish seams as the membrane is being installed (same day).
7. Anchor perimeter to deck or wall as specified.

SPEC WRITER NOTE: Retain Paragraph F for perimeter anchorage of systems.

F. Membrane Perimeter Anchorage:
1. Install batten strip or steel stress plate with fasteners at the perimeter of each roof level, curb flashing, expansion joints and similar penetrations as indicated in accordance with membrane manufacturer's instructions on top of roof membrane to wall or deck.
2. Mechanically fastened as follows:
   a. Top of mechanical fastener set flush with top surface of the nailing strip or stress plate.
   b. Space mechanical fasteners a maximum 300 mm (12 inches) on center.
   c. Start 25 mm (1 inch) from the end of the nailing strip when used.
   d. When strip is cut round edge and corners before installing.
   e. Set fasteners in lap sealant and cover fastener head with fastener sealer including batten strip or stress plate.
   f. Stop fastening strip where the use of the nailing strip interferes with the flow of the surface water, separate by a 150 mm (6 inch) space, then start again.
   g. After mechanically fastening cover and seal with a 225 mm (9 inch) wide strip of flashing sheet. Use splice adhesive on all laps and finish edge with sealant as specified.
   h. At gravel stops // facia-cants // turn the membrane down over the front edge of the blocking, cant, or the nailer to below blocking. Secure the membrane to the vertical portion of the nailer; with fasteners spaced not over 150 mm (6 inches) on centers.
   i. At parapet walls intersecting building walls and curbs, secure the membrane to the structural deck with fasteners 150 mm (6 inches) on center or as shown in NRCA manual (Fifth Edition)

SPEC WRITERS NOTE:
1. Delete paragraph G and H if a ballasted system is used.
2. Delete paragraph H if an adhered system is used.
3. Delete paragraph G if a mechanically anchored system is used.

G. 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 the deck with adhesive. Do not coat the lap joint area.
3. After adhesive has set according to adhesive manufacturer's application instruction, roll the membrane into the adhesive in manner that minimizes voids and wrinkles.
4. Repeat for other half of sheet. Cut voids and wrinkles to lay flat and clean for repair patch over cut area.

H. Mechanical Anchorage:
1. Secure the membrane to the structural deck with fasteners through stress plate or batten strips spaced and patterned in accordance with the membrane manufacturer's instructions to achieve a Factory Mutual // 1-60 // 1-90 // Wind Uplift rating.
2. When fasteners are installed within the laps of adjoining sheets, position the fastener so that the stress plates are a minimum 13 mm (1/2 inch) from the edge of the sheets.
3. Apply lap sealant under stress plate or batten strip and anchor to deck while lap sealant is still fluid. Cover fastener head with fastener sealer.
4. Where fasteners are installed over the membrane after the seams have been welded, cover the fasteners with a minimum 200 mm (8 inch) wide round EPDM membrane cap centered over the fastener stress plate. If batten strips are used cover the strip with a minimum 200 mm (8 inch) wide EDPM strip centered over the batten. Splice covers to roof membrane and finish edges with sealant as specified.
5. Before installing fasteners into cast in place concrete, pre-drill the correct size hole into the deck. Drill the hole 10 mm (3/8 inch) deeper than the fastener penetration.

I. Install flashings as the membrane is being installed (same day). If the flashing cannot be completely installed in one day, complete the installation until the flashing is in a watertight condition and provide temporary covers or seals.
SPEC WRITER NOTE:
1. Insure roof drain flashing details are shown with a dish to depress notched clamping ring below roof surface.
2. Offset drains in basin or dish to side of steel beams so drain is not above low point when roof slope terminates on top of beam.

J. Flashing Roof Drains:
1. Install roof drain flashing as recommended by the membrane manufacturer, generally as follows:
   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 the EPDM roof membrane.
   c. Adhere the EPDM roof membrane to the metal flashing with the membrane manufacturer's recommended bonding adhesive.
2. Turn down the metal drain flashing and EPDM roof membrane into the drain body and install clamping ring and stainer.

SPEC WRITER NOTE:
1. See NRCA EPDM manual (Fifth Edition) details for base flashing.
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.
7. Use 200 mm (8 inch) minimum height for base flashing.

M. Installing EPDM Base Flashing and Pipe Flashing:
1. Install EPDM flashing membranes to pipes, walls or curbs to a height not less than 200 mm (8 inches) above roof surfaces and 100 mm (4 inches) on roof membranes. Install in accordance with NRCA manual:
   a. Adhere flashing to pipe, wall or curb with bonding adhesive.
   b. Form inside and outside corners of EPDM flashing membrane in accordance with NRCA manual (Fifth Edition). Form pipe flashing in accordance with NRCA manual (Fifth Edition).
   c. Lap ends not less than 100 mm (4 inches).
d. Adhesively splice flashing membranes together and flashing membranes to roof membranes. Finish exposed edges with sealant as specified.

2. Anchor top of flashing to walls or curbs with fasteners spaced not over 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.

N. Installing Building Expansion Joints:

SPEC WRITER NOTE:
1. Do not put expansion joints at roof membrane level.
2. Design joints to be installed on curbs not less than 200 mm (8 inches) high.

1. Install base flashing on curbs as specified.

//2. Coordinate installation with metal expansion joint cover or roof expansion joint system. //

//2. Install flexible tubing 1-1/2 times width of joint over joint. Cover tubing with EPDM cover strip adhered to base flashing and lapping base flashing 100 mm (4 inches). Finish edges of laps with sealants as specified. //

O. Repairs to membrane and flashings:

1. Remove sections of EPDM sheet roofing or flashing that is 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. Adhesively splice to roof membrane or flashing. Finish edge of lap with sealant as specified.

3.4 INSTALLATION OF BALLAST SYSTEM AND PAVERS

SPEC WRITER NOTES:
1. Use pavers around equipment requiring servicing or having discharges detrimental to roof membrane, under gooseneck discharges from kitchens and chemical exhausts.
2. Clearly show on roof plan walkways and pavers.
3. Clearly show on roof plan location of aggregate ballast and weight for each location if not specified.
4. Design the rate of aggregate ballast applied and paver system in accordance with FM Data Sheets 1-7, 1-28, and Technical Advisory Bulletin (TAB) 1-29 for applicable site wind uplift.
5. Aggregate ballast:
   a. Increase weights and size of aggregate for wind design criteria as per FM TAB 1-29.
   b. When aggregate is used for a fire rated roof system larger aggregates require greater weights for fire rating.
   c. Specify weights for size aggregate used. See paragraph 3.2.C. Modify aggregate size and weights for fire and wind loads.
   d. Specify weights for perimeter, corners and field; within 1800 mm (6 feet) of the roof perimeter, for 3300 mm square (11 foot square) corner areas, for drain areas, and for large penetrations over 0.19 m² (2 square feet).
   e. Do not use less than 49 kg/m² (10 pounds per square foot) of aggregate for ballasted membranes requiring fire rating.
   f. Do not use aggregate in hurricane areas.

6. Pavers:
   a. Specify pavers and anchorage for pavers when weight of pavers does not meet the requirements for the wind velocities per FM TAB 1-29.
   b. Pavers without interlocking connectors require strapping together and edge clamps when they do not provide the minimum weight per m² (square foot) for wind uplift resistance. See paragraph 3.2, D, 4.
   c. Use mechanical strapping to create a perimeter anchor, at penetrations, cuts at valleys, over drains, and where partial or cut units occur.
   d. Detail strapping, perimeter restraints, edge clamps and location of strapping. Do not anchor through base flashing or into cants.
   e. Interlocking connectors:
      1) Use 400 mm (16 inches) on center minimum spacing of connectors.
      2) Decrease spacing to 300, 200, or 100 mm (12, 8, or 4 inches) on center for higher wind velocities.

A. Install as soon as roof membrane is laid.

B. Protective underpayment installation under ballast:
   1. Loose lay protection mat or separation sheet over roof membrane smooth and free of tension and stress without wrinkles. Do not stretch sheet.
2. Use full sheet width at perimeters with end laps held back not less than 3 m (10 feet) from roof edge at corners.
3. Lap ends not less than 300 mm (one foot).
4. Extend 50 to 75 mm (2 to 3 inches) above ballast at perimeter and penetrations.

C. Installation of aggregate:
1. Except where pavers are used, uniformly distribute aggregate over the protection mat.
2. Place _____ kg/m² (pounds per square foot) over a 1800 mm (6 foot) wide area around the perimeter, for an 3300 mm (11 foot) square corner area, for a 1200 mm (4 foot) square area around drains, and a 1200 mm (4 foot) wide area around penetrations over 600 mm (2 feet) square more than 1800 mm (6 feet) from the roof edge.
3. Place _____ kg/m² (pounds per square foot) over remaining roof areas.
4. Pavers may be substituted for aggregate over entire roof area.
   a. Paver weight equal to aggregate weight unless interlocking or strapped together and clamped down at roof edge.
   b. Interlocking pavers as required for wind exposure conditions and fire protection.

D. Installation of pavers:
1. Saw cut or core drill pavers for cut units.
2. Install pavers with butt joints in running bond with not less than 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.
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 each side of the valleys, hips, and ridges, with cross straps spaced not over 1200 mm (4 feet) on center between the end straps.
d. Install straps at the perimeter of the penetrations more than two paves in width or length.
e. Anchor straps to each paver with two fasteners per unit.
f. Pre-drill holes for fasteners in pavers.

3.5 WALKWAY PADS
A. Clean membrane where pads are applied.
B. Adhere pads to membrane with splicing cement.
C. Allow not less than 1 inch break between pads and 2 inch maximum break.

3.6 FIELD QUALITY CONTROL
A. Examine and probe seams in the membrane and flashing in the presence of the Resident Engineer and Membrane Manufacturer's Inspector.
B. Probe the edges of welded seams with a blunt tipped instrument. Use sufficient hand pressure to detect marginal bonds, voids, skips, and fishmouths.
C. Cut 100 mm (4 inch) wide by 300 mm (12 inch) long samples through the seams where directed by the Resident Engineer.
   1. Cut one sample for every 450 m (1500 linear feet) of seams.
   2. Cut the samples perpendicular to the longitudinal direction of the seams.
   3. Failure of the samples to maintain the standard of quality within a reasonable tolerance of the approved samples will be cause for rejection of the work.
D. Repair areas of welded seams where samples have been taken or marginal bond voids or skips occur.
E. Repair fishmouths and wrinkles by cutting to lay flat and installing patch over cut area extending 100 mm (4 inches) beyond cut.

3.7 TEMPORARY ROOF
A. Install temporary roof when sequences of work or weather does not permit installation of a completed permanent roof system or roof would be subject to phasing of roof work, construction traffic, scaffolds, and work over roof area.
B. Use of 1.15 mm (0.045-inch) thick non-reinforced EPDM membrane or other temporary membrane as approved.
   //C. Install not less than 6 mm (1/4 inch) thick plywood underlayment over steel decks before installing temporary roof.//
D. Secure membrane to deck with mechanical fasteners or temporary ballast not exceeding deck dead load capacity.
E. Repair cuts, tears, and punctures with patches to keep system watertight.
F. Install permanent roof system within one year.

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