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

PART 1 GENERAL

1.1 DESCRIPTION

A. Ethylene Propylene Diene Monomer (EPDM) sheet roofing ballasted to roof deck.

B. Fire rated roof system.

1.2 RELATED WORK

A. Roof Insulation: Section 07 22 00, ROOF AND DECK INSULATION.

B. Metal cap flashings, copings, fascias, and expansion joints: Section 07 60 00, FLASHING AND SHEET METAL.

1.3 QUALITY CONTROL

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 (R2004).....Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet and Strip
B209-07.....Aluminum and Aluminum-Alloy Sheet and Plate
D751-06.....Coated Fabrics
D2103-05.....Polyethylene Film and Sheeting
D2240-05.....Rubber Property - Durometer Hardness
D3884-07.....Abrasive Resistance of Textile Fabrics (Rotary Platform, Double-Head Method)
D4637-04.....EPDM Sheet Used in Single-Ply Roof Membrane
D4586-07.....Asphalt Roof Cement, Asbestos Free
E96-05.....Water Vapor Transmission of Materials
E108-07.....Fire Tests of Roof Coverings
G21-96 (R2002).....Resistance of Synthetic Polymeric Materials to Fungi

C. National Roofing Contractors Association (NRCA):

Fifth Edition - 05.....The NRCA Roofing and Waterproofing Manual.

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

2.1 EPDM SHEET ROOFING

A. Conform to ASTM D4637, Type I, Grade 1, white color.

B. Additional Properties:

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

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.
H. Asphalt Roof Cement: ASTM D4586.

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. Concrete and Masonry Wall Surfaces:
      a. Nail penetration 13 mm (1/2 inch).
   5. 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.
      b. Nails: Barbed shank, galvanized.
   6. Washers: Neoprene backed metal washer 28 mm (1-1/8 inch) minimum diameter.
   7. 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.

2.5 VAPOR RETARDER OR SEPARATION SHEETS

A. Polyethylene film: ASTM D2103, 0.2 mm (6 mils) thick.

B. Building Paper: Fed. Spec. UU-B-790.
   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 NOT USED

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).

2.9 BALLAST AND PAVERS

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

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 all surfaces 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. 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.
   8. 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.

3.2 PREPARATION

A. Test pull out resistance of fasteners in deck in the presence of the COTR 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 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. 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.

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 and 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)

G. 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.

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.

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.

3.4 INSTALLATION OF BALLAST SYSTEM

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. Uniformly, distribute aggregate over the protection mat.
   2. 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 m^2 (2 square feet). Place not less than 49 kg/m^2 (10 pounds per square foot) of aggregate for ballasted membranes requiring 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. 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 COTR 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.

- - - E N D - - -