

SECTION 07 51 00.13
BUILT-UP BITUMINOUS ROOFING, COLD-APPLIED

PART 1 - GENERAL

1.1 DESCRIPTION

This section includes cold-applied bituminous[hybrid] built-up roofing with //solar reflective granular coating// //solar reflective aggregate surfacing// //smooth surface with applied solar reflective coating//.

1.2 RELATED WORK

- A. General sustainable design documentation requirements: Section 01 81 13 SUSTAINABLE CONSTRUCTION REQUIREMENTS.
- B. Insulating Concrete Systems: Section 03 52 00, LIGHTWEIGHT CONCRETE ROOF INSULATION.
- C. Wood cants, blocking, and wood edge strips: Section 06 10 00, ROUGH CARPENTRY.
- D. Roof Insulation: Section 07 22 00, ROOF AND DECK INSULATION.
- E. Vapor barrier: Section 07 22 00, ROOF AND DECK INSULATION.
- F. Sheet metal components and wind uplift requirements for roof-edge design: Section 07 60 00, FLASHING AND SHEET METAL.
- G. Miscellaneous items: Section 07 71 00, ROOF SPECIALTIES/ Section 07 72 00, ROOF ACCESSORIES.

1.3 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. Editions of applicable publications current on date of issue of bidding documents apply unless otherwise indicated.
- B. American National Standards Institute/Single-Ply Roofing Institute (ANSI/SPRI):
 ANSI/SPRI ES-1-03.....Wind Design Standard for Edge Systems
 Used with Low Slope Roofing Systems
- C. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
 ASCE/SEI-7-10.....Minimum Design Loads for Buildings and
 Other Structures

- D. Asphalt Roofing Manufacturers Association/National Roofing Contractors Association (ARMA/NRCA): Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing
- E. ASTM International (ASTM):
- C1370-00 (2012).....Determining the Chemical Resistance of Aggregates for Use in Chemical-Resistant Sulfur Polymer Cement Concrete and Other Chemical-Resistant Polymer Concretes
 - C1371-10.....Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
 - C1549-09.....Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
 - D146-04 (2012).....Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
 - D1644-01 (2012).....Nonvolatile Content of Varnishes
 - D1863-05.....Mineral Aggregate Used on Built-Up Roofs
 - D2178-04.....Asphalt Glass Felt Used in Roofing and Waterproofing
 - D2523-00 (R2006).....Testing Load-Strain Properties of Roofing Membranes
 - D2823-05.....Asphalt Roof Coatings, Asbestos Containing
 - D3909-97 (2012).....Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules
 - D3960-05.....Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
 - D4073-06.....Tensile-Tear Strength of Bituminous Roofing Membranes
 - D4263-83 (R2005).....Indicating Moisture in Concrete by the Plastic Sheet Method
 - D4586-07.....Asphalt Roof Cement, Asbestos Free
 - D4601-04.....Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing

- D4897-09.....Asphalt Coated Glass Fiber Venting Base
Sheet Used in Roofing
- D5147-07.....Sampling and Testing Modified Bituminous
Sheet Material
- D5201-05 (R2010).....Calculating Formulation Physical
Constants of Paints and Coatings
- D6162-00 (R2008).....Styrene Butadiene Styrene (SBS) Modified
Bituminous Sheet Materials Using a
Combination of Polyester and Glass Fiber
Reinforcements
- D6163-00 (R2008).....Styrene Butadiene Styrene (SBS) Modified
Bituminous Sheet Materials Using Glass
Fiber Reinforcements
- D6164-11.....Styrene Butadiene Styrene (SBS) Modified
Bituminous Sheet Materials Using
Polyester Reinforcements
- D6511-06.....Solvent Bearing Bituminous Compounds
- E108-10.....Fire Tests of Roof Coverings
- E408-71 (R2008).....Total Normal Emittance of Surfaces Using
Inspection-Meter Techniques
- E1918-06.....Measuring Solar Reflectance of Horizontal
and Low-Sloped Surfaces in the Field
- E1980-01.....Measuring Solar Reflectance of Horizontal
and Low-Sloped Surfaces in the Field
- F. American Society of Heating, Refrigeration, and Air Conditioning
Engineers (ASHRAE)
- ASHRAE 90.1-2010.....Energy Standard for Buildings Except Low-
Rise Residential Buildings, Appendix f.
- G. Cool Roof Rating Council:
- CRRC-1.....Product Rating Program, www.coolroofs.org
- H. FM Approvals: RoofNav Approved Roofing Assemblies and Products.
- 4450-89.....Approved Standard for Class 1 Insulated
Steel Deck Roofs
- 4470-10.....Approved Standard for Class 1 Roof
Coverings
- 1-28-09.....Loss Prevention Data Sheet: Design Wind
Loads.

1-49-09.....Loss Prevention Data Sheet: Perimeter
Flashing

- I. National Roofing Contractors Association: Roofing and Waterproofing Manual
- J. U.S. Environmental Protection Agency (EPA):
EPA 600/R-93/116.....Method for the Determination of Asbestos
in Bulk Building Materials
- K. U.S. Department of Agriculture (USDA): USDA BioPreferred Catalog,
www.biopreferred.gov
- L. U.S. Department of Energy (DoE): Roof Products Qualified Product
List, www.energystar.gov

1.4 PERFORMANCE REQUIREMENTS

- A. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing manufacturer based on testing and field experience.
- B. Roofing Membrane System Load-Strain Properties: Provide a roofing membrane identical to component systems that have been successfully tested by a qualified independent testing and inspecting agency to meet the following minimum load-strain properties at membrane failure when tested according to ASTM D2523:
 - 1. Tensile strain at failure, at 0 deg F (-18 deg C): //600 lbf(2.67 kN)// cross machine direction, minimum; //4.0 to 5.5// percent elongation at break.
- C. Roofing System Energy Performance Requirements: Provide a roofing system identical to components that that have been successfully tested by a qualified independent testing and inspecting agency to meet the following requirements:
 - 1. Energy Performance, Energy Star: Provide roofing system that is listed on DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.
 - 2. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E1980 based on testing identical products by a qualified testing agency.

3. Energy Performance, CRRC-1: Provide roofing system with initial solar reflectance not less than 0.70 and emissivity not less than 0.75 when tested according to CRRC-1.
4. Energy Performance, Aged: Provide roofing system with minimum three-year aged solar reflectance not less than 0.55 when tested in accordance with ASTM C1549 or ASTM E1918, and in addition, a minimum three-year-aged thermal emittance of 0.75 when tested in accordance with ASTM C1371 or ASTM E408.
 - a. Where tested aged values are not available for proposed product, submit calculations to adjust initial solar reflectance to demonstrate compliance as indicated in ASHRAE 90.1-2007 Addendum f.
 - b. Alternatively, provide roofing system with minimum three-year aged Solar Reflectance Index of not less than 64 when determined in accordance with the Solar Reflectance Index method in ASTM E1980 using a convection coefficient of 2.1 BTU/h-ft² (12 W/m²K).

1.5 QUALITY CONTROL

- A. Installer Qualifications:
 1. Licensed or approved in writing by manufacturer to perform work under warranty requirements of this Section.
 2. Employ full-time supervisors knowledgeable and experienced in roofing of similar types and scopes, and able to communicate with owner and workers.
- B. Inspector Qualifications: Inspection of work by third-party technical inspector or technical representative of manufacturer experienced in the installation and maintenance of the specified roofing system, qualified to perform roofing observation and inspection specified in Field Quality Control Article, to determine Installer's compliance with the requirements of this Project, and approved by the manufacturer to issue warranty certification. The Roofing Inspector shall be one of the following:
 1. An authorized full-time technical employee of the manufacturer, not engaged in the sale of products.
 2. An independent party certified as a Registered Roof Observer by the Roof Consultants Institute (RCI), retained by the

Contractor or the Manufacturer and approved by the Manufacturer.

C. Product/Material Requirements:

1. Obtain products from single manufacturer or from sources recommended by manufacturer for use with roofing system and incorporated in manufacturer's warranty.
2. Provide manufacturer's certification that field applied bituminous coatings and mastics, and field applied roof coatings comply with limits for Volatile Organic Compounds (VOC) per the National Volatile Organic Compound Emission Standards for Architectural Coatings pursuant to Section 183(e) of the Clean Air Act with limits as follows:
 - a. Bituminous Coatings and Mastics: 500 g/l (4.2 lb/gal.).
 - b. Roof Coatings: 250 g/l (2.1 lb/gal.).
3. Bio-Based Materials: For products designated by the USDA's Bio-Preferred program, provide products that meet or exceed USDA recommendations for bio-based content, so long as products meet all performance requirements in this specification section. For more information regarding the product categories covered by the Bio-Preferred program, visit <http://www.bio-preferred.gov>

D. Roofing system design standard requirements:

1. Recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to modified bituminous sheet roofing for storage, handling and application.
2. Recommendations of FM Approvals 1-49 Loss Prevention Data Sheet for Perimeter Flashings.
3. Recommendations of ANSI/SPRI ES-1 for roof edge design.
4. Roofing System Design: Provide roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressure calculated according to ASCE/SEI 7.
 - a. Corner Uplift Pressure: //00 kPa/sq. m (00 lbf/sq. ft.)//.
 - b. Perimeter Uplift Pressure: //00 kPa/sq. m (00 lbf/sq. ft.)//.
 - c. Field-of-Roof Uplift Pressure: //00 kPa/sq. m (00 lbf/sq. ft.)//.

5. FM Approvals Listing: Provide roofing membrane, base flashing, and component materials that comply with requirements in FM Approvals 4450 and FM Approvals 4470 as part of a roofing system and that are listed in FM Approvals "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Approvals markings.
 - a. Fire/Windstorm Classification: Class 1A-//60// //75//
//90// //105// //120//.
 - b. Hail Resistance: //MH// //SH//.
 6. High Wind Zone Design Requirement: Contractor Option: In lieu of FM Approval Listing windstorm classification, provide roofing membrane, base flashing, and component materials that comply with Miami-Dade County requirements.
- E. 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.

1.6 SUBMITTALS

- A. Submit in accordance with Section 01 33 23, SHOP DRAWINGS, PRODUCT DATA, SAMPLES.
- B. Product Data:
 1. Asphalt and adhesive materials.

2. Base and ply sheet roofing and flashing membrane.
 3. Roofing cement.
 4. Fastening requirements.
 5. Roof walkway.
 6. Aggregate surfacing and surfacing adhesive.
 7. Coating.
 8. Application instructions.
- C. Federal Sustainable Design Submittals:
1. For roof materials, indicating that roof materials comply with Solar Reflectance Index requirement.
 2. For adhesives and sealants used inside the weatherproofing system, documentation including printed statement of VOC content.
 3. Federally-Mandated Bio-Based Materials: For roof materials, indicating USDA designation and compliance with definitions for bio-based products, Rapidly Renewable Materials, and certified sustainable wood content.
- D. Samples:
1. Nails and fasteners, each type.
- E. Shop Drawings: Include plans, sections, details, and attachments.
1. Base flashings and terminations.
 4. Nailers and cants.
- F. Certificates:
1. Indicating materials and method of application of roofing system meets requirements of FM Approvals "RoofNav" for specified fire/windstorm classification.
 2. Indicating compliance with Miami-Dade County requirements.
 3. Indicating compliance with load/strain properties requirement.
 4. Indicating compliance with energy performance requirement.
- G. Warranty: As specified.
- H. Documentation of supervisors' and inspectors' qualifications.
- I. Field reports of roofing inspector.
- J. Temporary protection plan. Include list of proposed temporary materials.
- K. Contract Close-out Submittals:
1. Maintenance Manuals.
 2. Warranty signed by installer and manufacturer.

1.7 DELIVERY, STORAGE AND MARKING

- A. Comply with the recommendations of the NRCA "Roofing and Waterproofing Manual" applicable to built-up roofing for storage, handling and installation.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
- B. Environmental Controls: Refer to Section 01 57 19, TEMPORARY ENVIRONMENTAL CONTROLS.
- C. Protection of interior spaces: Refer to Section 01 00 00, GENERAL REQUIREMENTS.

1.9 WARRANTY

- A. Roofing system is subject to terms of "Warranty of Construction", FAR clause 52.246-21, except that warranty period is extended to [10] years.

PART 2 - PRODUCTS**2.1 ADHESIVE AND ASPHALT MATERIALS:**

- A. General: 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.
 - 1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
 - 2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
 - a. Multipurpose Construction Adhesives: 70 g/L.
 - b. Contact Adhesives: 80 g/L.
 - c. Other Adhesives: 250 g/L.
 - d. Nonmembrane Roof Sealants: 300 g/L.
 - e. Sealant Primers for Nonporous Substrates: 250 g/L.
 - f. Sealant Primers for Porous Substrates: 775 g/L.

- B. Water-Based Asphalt Primer: Water-based, polymer modified, asphalt primer with the following physical properties:
 - 1. Asbestos Content, EPA 600/R13/116: None.
 - 2. Non-Volatile Content, minimum, ASTM D2823: 30 percent.
 - 3. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 65 g/L.
- C. Cold-Applied Adhesive for sheet membrane: One-part, asbestos-free, low-volatile, cold-applied adhesive specially formulated for compatibility and use with specified roofing membranes and flashings, with the following physical properties:
 - 1. Asbestos Content, EPA 600/R13/116: None.
 - 2. Volatile Organic Compounds (VOC), maximum, ASTM D6511: <250 g/L.
 - 3. Nonvolatile Content, minimum, ASTM D6511: 75 percent.
 - 4. Uniformity and Consistency, ASTM D6511: Pass.
- D. Cold-Applied Adhesive for membrane flashing: One-part, cold-applied adhesive specially formulated for compatibility and use with specified roofing membranes and flashings, with the following physical properties:
 - 1. Asbestos Content, EPA 600 R13/116: None.
 - 2. Volatile Organic Compounds (VOC), maximum, ASTM D6511: <250 g/L.
 - 3. Nonvolatile Content, minimum, ASTM D6511: 75 percent.
 - 4. Uniformity and Consistency, ASTM D6511: Pass.
- E. Roof Cement: ASTM D4586, Type II.

2.2 MEMBRANE AND SHEET MATERIALS:

- A. Membrane Materials, General: Provide combination of base, ply, and cap sheet materials that have been tested in combination and comply with load/strain properties performance requirement in Part 1 of this Section.
- B. Base Sheet: ASTM D4897, Type II, venting, nonperforated, heavyweight, asphalt-impregnated and coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

- C. Base Sheet: ASTM D4601, Type II, nonperforated, asphalt-impregnated and coated glass-fiber sheet dusted with fine mineral surfacing on both sides, with the following properties:
 - 1. Breaking Strength, minimum, ASTM D146: cross machine direction, 12.2 kN/m (70 lbf/in).
 - 2. Pliability, 12.7 mm (1/2 inch) radius bend, ASTM D146: No failures.
- D. Base Sheet: ASTM D4601, Type II or III, nonperforated, asphalt-coated, composite polyester/fiberglass/polyester reinforced sheet dusted with fine mineral surfacing on both sides, with the following properties:
 - 1. Breaking Strength, minimum, ASTM D146: cross machine direction, 21.0 kN/m (120 lbf/in).
 - 2. Tear Strength, minimum, ASTM D4073: cross machine direction, 880 N (200 lbf).
 - 3. Pliability, 12.7 mm (1/2 inch) radius bend, ASTM D146: No failures.
- E. Ply Sheet: ASTM D 4601, Type II, nonperforated, asphalt-impregnated and coated glass-fiber sheet dusted with fine mineral surfacing on both sides, with the following properties:
 - 1. Breaking Strength, minimum, ASTM D 146: machine direction, 90 lbf/in; cross machine direction, 70 lbf/in.
- F. Cap Sheet: Same as ply sheet.
- G. Cap Sheet: ASTM D3909, asphalt-impregnated and -coated, glass-fiber cap sheet, with white coarse mineral-granule top surfacing and fine mineral surfacing on bottom surface.
- H. Cap Sheet: ASTM D6163, Grade G, Type II, glass-fiber-reinforced, SBS/SEBS/SIS modified asphalt sheet; granular surfaced; and as follows:
 - 1. Exterior Fire-Test Exposure, ASTM E108: Class A.
 - 2. Tensile Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 24 kN/m (140 lbf/in).
 - 3. Tear Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 880 N (200 lbf).
 - 4. Elongation at 23 deg. C (73 deg. F), minimum, cross machine direction, at 5 percent maximum load ASTM D5147: 40 percent.
 - 5. Low Temperature Flex, maximum, ASTM D5147: -31 deg. C (-25 deg. F).

- I. Cap Sheet: ASTM D6163, Grade G, Type II, glass-fiber-reinforced, SBS-modified asphalt sheet; granular surfaced with a factory applied, white, reflective, acrylic coating; CRRC listed and California Title 24 Energy Code compliant; and as follows:
 - 1. Exterior Fire-Test Exposure, ASTM E108: Class A.
 - 2. Tensile Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 12.2 kN/m (70 lbf/in).
 - 3. Tear Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 440 N (100 lbf).
 - 4. Elongation at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 7.5 percent.
 - 5. Low Temperature Flex, maximum, ASTM D5147, -26 deg. C (-15 deg. F).
 - 7. Reflectance, ASTM C1549: 71 percent.
 - 8. Thermal Emittance, ASTM C1371: 0.87.
 - 9. Solar Reflectance Index (SRI), ASTM E1980: 87.
- J. Cap Sheet: ASTM D6162, Grade G, Type III, composite polyester and glass-fiber-reinforced, SBS/SEBS-modified asphalt sheet; granular surfaced with a factory applied, white, reflective, acrylic coating; CRRC listed and California Title 24 Energy Code compliant; and as follows:
 - 1. Exterior Fire-Test Exposure, ASTM E108: Class A.
 - 2. Tensile Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 84 kN/m (480 lbf/in).
 - 3. Tear Strength at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 330 N (750 lbf).
 - 4. Elongation at 23 deg. C (73 deg. F), minimum, cross machine direction, ASTM D5147: 6 percent.
 - 5. Low Temperature Flex, maximum, ASTM D5147, -26 deg. C (-15 deg. F).
 - 6. Reflectance, ASTM C1549: 75 percent.
 - 7. Thermal Emittance, ASTM C1371: 0.86.
 - 8. Solar Reflectance Index (SRI), ASTM E1980: 92.
- K. Base Flashing Backer Sheet: ASTM D4601, Type II, asphalt-impregnated and coated, glass-fiber sheet, dusted with fine mineral surfacing on both sides.
- L. Base Flashing Backer Sheet: Same as ply sheet.

- M. Base Flashing Sheet: ASTM D6164, Grade G, Type II, polyester-reinforced, SBS-modified asphalt sheet; granular surfaced; Granule Color: White.

2.3 FASTENERS:

- A. Roofing Fasteners: Factory-coated steel fasteners and metal or plastic plates, where applicable, meeting requirements of FM Approvals 4470, tested by fastener manufacturer for required pullout strength, and recommended by roofing manufacturer for application.
- B. Accessory Fasteners: Corrosion-resistant fasteners compatible with adjacent materials and recommended for application by manufacturer of component to be fastened.

2.4 COATINGS

- A. White Roof Coating: Water-based, Energy Star Certified, CRRC listed and California Title 24 Energy Code compliant elastomeric roof coating formulated for use on bituminous roof surfaces, with the following physical properties:
1. Asbestos Content, EPA/600/R13/116: None.
 2. Non-Volatile Content (by weight), minimum, ASTM D1644: 60 percent.
 3. Volatile Organic Compounds (VOC), ASTM D3960: 35g/L.
 4. Percent Solids (by volume), minimum, ASTM D5201: 60 percent.
 5. Reflectance, minimum, ASTM C1549: 86 percent.
 6. Emissivity, minimum, ASTM C1370: 0.93.
 7. Solar Reflectance Index (SRI), ASTM E1980: 103.
- B. White Roof Coating: Intumescent, fire-retardant, Energy Star Certified, CRRC listed and California Title 24 Energy Code compliant, elastomeric, acrylic latex roof coating formulated for use on bituminous roof surfaces, with the following physical properties:
1. Asbestos Content, EPA/600/R13/116: None.
 2. Non-Volatile Content (by weight), minimum, ASTM D1644: 67 percent.
 3. Reflectance, minimum, ASTM WK29032: 82 percent.
 4. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 155 g/L.
 5. Solar Reflectance Index (SRI), ASTM E1980: 103.

2.5 SURFACING AND COATINGS

- A. Aggregate Surfacing, Stone: ASTM D1863, except the use of crushed stone is prohibited.
- B. Aggregate Surfacing, Slag or Gravel: Use slag on slopes over 1:10 (one inch per foot).
- C. Aggregate Surfacing, Solar Reflective: White marble aggregate, Solar Reflectance Index (SRI) when applied with specially formulated white adhesive, Hardness 3.5 Mohs.
- D. Aggregate Surfacing Adhesive: Cold-applied surfacing adhesive, with VOC content less than 250 g/L, formulated for fire-resistant properties.
- E. Aggregate Surfacing Adhesive, Solar Reflective: One-part, white, highly reflective polymeric surfacing adhesive, CRRC listed and California Title 24 Energy Code compliant when combined with approved white gravel, with following physical properties:
 - 1. Asbestos Content, EPA 600 R-93/116: None.
 - 2. Volatile Organic Compounds (VOC), maximum, ASTM D 6511: 250 g/L.
 - 3. Nonvolatile Matter, minimum ASTM D 6511: 50 percent.
 - 4. Reflectance (adhesive plus aggregate), ASTM C 1549: 71 percent.
 - 5. Thermal emittance (adhesive plus aggregate), ASTM C 1371: 0.85.
 - 6. Solar Reflectance Index (SRI), adhesive plus gravel, ASTM E 1980: 86.
- F. White Roof Coating: Water-based, Energy Star Certified, CRRC listed and California Title 24 Energy Code compliant elastomeric roof coating formulated for use on bituminous roof surfaces, with the following physical properties:
 - 1. Asbestos Content, EPA/600/R13/116: None.
 - 2. Non-Volatile Content (by weight), minimum, ASTM D 1644: 60 percent.
 - 3. Volatile Organic Compounds (VOC), ASTM D 3960: 35g/L.
 - 4. Percent Solids (by volume), minimum, ASTM D 5201: 60 percent.
 - 5. Reflectance, minimum, ASTM C 1549: 86 percent.
 - 6. Emissivity, minimum, ASTM C 1370: 0.93.
 - 7. Solar Reflectance Index (SRI), ASTM E 1980: 103.

G. White Roof Coating: Intumescent, fire-retardant, Energy Star Certified, CRRC listed and California Title 24 Energy Code compliant, elastomeric, acrylic latex roof coating formulated for use on bituminous roof surfaces, with the following physical properties:

1. Asbestos Content, EPA/600/R13/116: None.
2. Non-Volatile Content (by weight), minimum, ASTM D 1644: 67 percent.
3. Reflectance, minimum, ASTM WK 29032: 82 percent.
4. Volatile Organic Compounds (VOC), maximum, ASTM D 3960: 155 g/L.
5. Solar Reflectance Index (SRI), ASTM E 1980: 103.

2.6 ROOF WALKWAY:

- A. Prefabricated asphalt plank consisting of a homogeneous core of asphalt, plasticizers and inert fillers, bonded by heat and pressure between two saturated and coated sheets of felt:
1. Top side of plank surfaced with ceramic granules. Granule Color: White.
 2. Size: Minimum 13 mm (1/2-inch) thick, manufacturer's standard size, but not less than 300 mm (12 inches) in least dimension and 600 mm (24 inches) in length.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine substrates and conditions with roofing Installer and roofing inspector to verify compliance with project requirements and suitability to accept subsequent roofing work. Correct unsatisfactory conditions before proceeding with roofing work.
- B. Do not apply roofing if roof surface will be used for subsequent work platform, storage of materials, or staging or scaffolding will be erected thereon unless system is protected.

3.2 PREPARATION

- A. Complete roof deck construction prior to commencing roofing work:
1. Install curbs, blocking, edge strips, nailers, cants, and other components where insulation, roofing, and base flashing

is attached to, in place ready to receive insulation and roofing.

2. Complete deck and insulation to provide designed drainage to working **roof drains**.
 3. Document installation of related materials to be concealed prior to installing roofing work.
- B. 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. Apply materials to dry substrates.
- C. Sweep decks to broom clean condition. Remove all dust, dirt or debris.
- D. Remove projections that might damage materials.
- E. Concrete Decks, except Insulating Concrete:
1. Test concrete decks for moisture prior to application of roofing materials. Test for capillary moisture by plastic sheet method according to ASTM D4263.
 2. Prime concrete decks, including precast units, with primer as specified. Keep primer back four inches from joints in precast units.
 3. Allow primer to dry before application of bitumen.
- F. Insulating Concrete Decks:
1. Allow to dry out for at least five days after installation before the placement of materials.
 2. If rain occurs during or at end of drying period or during installation of roofing, allow additional drying time before the placement of the roofing materials.
- G. Poured Gypsum Decks: Dry out poured gypsum in accordance with manufacturer's printed instructions prior to application of roofing materials.
- H. Existing Membrane Roofs and Repair Areas:
1. Comply with requirements in Section 07 01 50.19 PREPARATION FOR REROOFING.
 2. At areas to be altered or repaired, remove loose, damaged, or cut sheet that is not firmly adhered only where new penetrations occur or repairs are required.
 3. Cut and remove existing roof membrane for new work to be installed. Clean cut edges and install a temporary seal to cut surfaces. Use roof cement and one layer of 7 Kg (15 pound)

felt strip cut to extend 150 mm (6 inches) on each side of cut surface. Bed strip in roof cement and cover strip with roof cement to completely embed the felt.

4. At base flashing to be repaired, either bend up cap flashing or temporarily remove cap flashing. Brush and scrape away all deteriorated sheets or surface material of base flashing.

3.3 TEMPORARY PROTECTION

- A. Install temporary protection at the end of day's work and when work is halted for an indefinite period or work is stopped when precipitation is imminent. Comply with approved temporary protection plan.
- B. Install temporary cap flashing over the top of base flashings where permanent flashings are not in place to provide protection against moisture entering the roof system through or behind the base flashing. Securely anchor in place to prevent blow off and damage by construction activities.
 1. Glaze coat exposed surfaces of felts to seal within the bitumen coating. Do not leave felt surfaces or edges exposed.
- C. Provide for removal of water or drainage of water away from the work.
- D. Provide temporary protection over installed roofing by means of duckboard walkways, plywood platforms, or other materials, as approved by Resident Engineer, for roof areas that are to remain intact, and that are subject to foot traffic and damage. Provide notches in sleepers to permit free drainage.

3.4 INSTALLATION, GENERAL

- A. FM Approvals Installation Standard: Install roofing membrane, base flashings, wood cants, blocking, curbs, and nailers, and component materials in compliance with requirements in FM 4450 and FMG 4470 as part of a membrane roofing system as listed in FM Approval's "RoofNav" for fire/windstorm classification indicated. Comply with recommendations in FM Approvals' Loss Prevention Data Sheet 1-49, including requirements for wood nailers and cants.
- B. NRCA Installation Standard: Install roofing system in accordance with applicable NRCA Manual Plates and NRCA recommendations, including ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing"

- C. Manufacturer Recommendations: Comply with roofing system manufacturer's written installation recommendations.
- D. Coordination with related work: Coordinate roof operations with roof insulation and sheet metal work so that insulation and flashings are installed concurrently to permit continuous roofing operations.
- E. Installation Conditions:
 - 1. Apply dry roofing materials. Apply roofing work over dry substrates and materials.
 - 2. Apply materials within temperature range and surface and ambient conditions recommended by manufacturer.
 - 3. Except for temporary protection, do not apply materials during damp or rainy weather, during excessive wind conditions, nor while moisture (dew, snow, ice, fog or frost) is present in any amount in or on the materials to be covered or installed:
 - a. Do not apply materials when the temperature is below 4 deg. C (40 deg. F).
 - b. Do not apply materials to substrate having temperature of 4 deg. C (40 deg. F) or less.

3.5 INSTALLATION OF BUILT-UP BITUMINOUS ROOFING

- A. Primer: Apply primer to substrates where recommended by roofing manufacturer, in application quantities recommended by roofing manufacturer.
- B. Cold-Applied Adhesive:
 - A. Apply cold-applied adhesive in a uniform application at rate recommended by manufacturer.
- C. Built-Up Membrane Sheets:
 - 1. Number of Plies: [4], minimum, including cap sheet, and not including base sheet if any. Provide additional plies as required to meet load/strain properties specified in Part 1 of this Section.
 - 2. Commence the laying of sheets at the low points.
 - 3. Roll sheets into cold-applied adhesive brushing down to firmly embed, free of wrinkles, fish mouths, blisters, bubbles, voids, air pockets or other defects that prevent complete adhesion:

4. Cut to fit closely around pipes, roof drains, bitumen stops, and similar roof projections.
5. Lap sheets shingle fashion starting with starter strips at right angles to slope of roof.
6. Laps for base sheet and ply sheets:
 - a. Base sheet, lapped 50 mm (2-inches).
 - b. Two plies with 450 mm (18-inches) and 900 mm (36-inch) starting widths, lapped 480 mm (19-inches).
 - c. Three plies with 300 mm (12-inches) 600 mm (24-inches) and 900 mm (36-inch) starting widths, lapped 624 mm (24-1/2 inches).
 - d. Four plies with 230, 460, 690 and 900 mm (9, 18, 27 and 36-inch) starting widths, lapped 700 mm (27-1/2 inches).
 - e. End joints of ply and base sheet, lapped 50 mm (2-inches). Stagger end joints in relation to joints in adjacent and proceeding plies.

D. Roofing on Nailable Decks:

1. On insulating concrete, install one ply of venting base sheet with mineral aggregate surface down, nailed to deck with lap as specified and seal lap edges with roof cement. Terminate venting base sheet as follows:
 - a. At vertical surfaces: Extend venting base sheet up vertical surface over cants to top of base flashing or curb.
 - b. At roof edge under gravel stops install venting base sheet over blocking: Extend base sheet not less than two inches beyond outer edge and turn down so that venting can be accomplished.
 - c. At roof edge over fascia-cant: Extend base sheet over top of cant and turn down over outer face of cant to permit venting at the edge.
2. On poured gypsum, precast gypsum plank, cement-wood fiber plank, wood plank, or plywood decks install one layer of building paper followed by base sheet.
 - a. Apply building paper lapping ends and edges 50 mm (two inches) Lay smoothly without buckles or wrinkles. Staple or nail sufficiently to hold in place until roof membrane is installed.

- b. One ply of venting base sheet. Lay base sheet down dry on deck, Nail as specified. Lap as specified and seal lap edges with roof cement.

E. Roof edges and terminations:

1. Where nailers occur at roof edges under gravel stops or penetrations to receive metal base flashing, apply a continuous strip of underlayment over the nailers before the first ply sheet is applied. Strip shall be installed on top of venting base sheet if any.
2. After membrane is installed, turn the underlayment back over the roofing, and secure in place with cold-applied adhesive before gravel stops or other metal flanges extending out onto the membrane are installed.
3. Where cants occur at vertical surfaces, cut off roofing sheets two inches above top of cant strips, except at prefabricated curbs, scuttles and other roof accessories having integral cants, extend membrane over cant and up vertical surface to top of curb or nailer as shown.
4. Where fascia-cant occurs at roof edges, extend membrane beyond outside cant face and cut off at outside after base flashing is installed.
5. Where reglet occurs at vertical surfaces, extend plies roofing sheets up into reglet the full depth of the reglet.

F. Base Sheet Installation:

1. One ply of base sheet dry to deck, except mop between laps. Lap and attach as specified to deck.

G. Venting Base Sheet Installation:

1. At vertical surfaces: Extend venting base sheet up vertical surface over cants to top of base flashing or curb.
2. At roof edge under gravel stops install venting base sheet over blocking: Extend base sheet not less than 50 mm (2-inches) beyond outer edge and turn down to allow venting at the edge.
3. At roof edge over fascia-cant: Extend base sheet over top of cant and turn down over outer face of cant to allow venting at the edge.

H. Roof Ply Installation:

1. Extend first ply sheet 100 mm (4-inches) beyond the insulation and the second ply sheet 75 mm (3-inches) beyond the first. Lap ends 75 mm (3-inches) with joints broken 450 mm (18-inches) in each ply.

I. Cap Sheet Installation:

1. Install cap sheet in a solid application of cold-applied adhesive.
2. Extend cap sheet 100 mm (4-inches) beyond the underlying ply 75 mm (3-inches). Lap ends 75 mm (3-inches) with joints broken 450 mm (18-inches) in each ply.

3.6 BASE FLASHING:

- A. Prime vertical surfaces of masonry and concrete with asphalt primer except where vented base sheet is required to provide edge venting.
- B. Apply flashing on top of built-up roofing, up face of cant and vertical surfaces, at least 200 mm (8-inches) above the roof, full height beneath counter flashing or top of curb flashing:
 1. At fascia-cants, extend to top of cant and cut off.
 2. Extend plies of roofing into reglet the full depth of the reglet.
- C. Except at metal fascia cants, secure top edge of base flashing with nails on a line approximately one inch below top edge, spaced not more than 200 mm (8-inches) on center.
 1. Cover all nail heads with roof cement.
 2. Cover the top of the base flashing with counter flashing as specified in Section 07 60 00, FLASHING AND SHEET METAL. At the cants secure the top edge of the flashing with fascia compression clamp as specified in Section 07 60 00, FLASHING AND SHEET METAL.
- D. Install flashing using longest pieces practicable. Complete splices between flashing and main roof sheet before bonding to vertical surface. Seal splice not less than 76mm (3-inches) beyond fasteners that attach membrane to blocking. Apply bonding adhesive to both flashing and surface to which flashing is being adhered per manufacturer recommendations. Nail top of flashing 300mm (12-inches) on center under metal counter flashing or cap.

1. Parapet Walls: Extend up parapet and turn over top edge. Apply with 100 percent adhesive.
- E. Install flashing over cants to make system watertight.
- F. Install flashing before final roofing coat and aggregate are installed.

3.7 STRIPPING:

- A. Set flanges of metal flashing in roof cement before the final bituminous coat and roof aggregate are installed and nail to blocking per Section 07 60 00, FLASHING AND SHEET METAL.
- B. Before the final bituminous coat and aggregate are installed, cover that portion of the horizontal flanges of metal base flashing, gravel stops and other flanges, extending onto the roofing with flashing sheet.

3.8 AGGREGATE SURFACING:

- A. After bituminous base flashing and stripping has been installed, uniformly coat the entire roof surface, except cants, with bitumen pour coat at the rate scheduled.
- C. Embed aggregate to cover the roofing sheet completely without bare spots, but not less than 20 Kg/m² (400 pounds/) of dry gravel or 15 Kg/m² (300 pounds/100 square feet) of dry slag per. Do not leave any exposed bitumen.
- D. Do not embed aggregate under roof walkways.
- E. In cold weather preheat aggregate prior to application.
- F. Do not place aggregate material in piles or rows on bare or glaze coated felt.
- G. If aggregate surfacing is delayed, promptly apply glaze coat of cold-applied adhesive at rate scheduled.

3.9 REPAIR AND ALTERATIONS TO EXISTING ROOF

- A. Areas to be altered or repaired, remove loose aggregate and aggregate not firmly embedded where new penetrations occur or repairs are required:
 1. Remove aggregate 900 mm (3 feet) beyond areas to be cut.
 - a. Clean, dry and store aggregate away from roof area until ready to reuse.
 - b. Remove unsuitable and excess aggregate not used from Project.

- B. Cut and remove existing roof membrane for new work to be installed. Clean cut edges and install a temporary seal to cut surfaces. Use roof cement and one layer of 7 Kg (15 pound) felt strip cut to extend 150 mm (6 inches) on each side of cut surface. Bed strip in roof cement and cover with roof cement to completely embed the felt.
- C. Bend up cap flashing or temporarily remove at built-up base flashing to be repaired. Brush and scrape away deteriorated and loose bitumen, felts or surface material of built-up base flashing.
- D. Repairs to existing membrane and base flashing:
 - 1. Remove temporary patches prior to starting new work.
 - 2. Blisters and fish mouths:
 - a. Cut blisters open and turn membrane back to fully adhered portion. Cut fish mouths so membrane can be turned back and subsequently laid flat.
 - b. Heat membrane to facilitate bending and to dry surface of exposed blister areas.
 - c. Mop turned back membrane in cold-applied adhesive. Roll to insure full adhesion and embedment in substrate.
 - d. Cover cut areas with two plies of felt. Extend first ply 100 mm (4-inches) beyond cut area edge. Extend second 100 mm (4 inches) beyond first ply. Mop down in cold-applied adhesive as specified for new work. Resurface to match existing.
 - 3. Exposed Felts:
 - a. Cut away exposed deteriorated edges of sheets.
 - b. Glaze coat felt edges.
 - c. Resurface to match existing.
 - 4. Built-up Base Flashing:
 - a. Restore felts and cap sheet removed, lapping 100 mm (4-inches) over existing.
 - b. Install new felts and cap sheet as specified for new work.
 - 5. Horizontal Metal Flanges:
 - a. Remove loose, buckled or torn stripping.
 - b. Remove loose fasteners and install new fasteners.
 - c. Restrip flanges as specified for new work.

6. Resurfacing:

- a. Over repaired membrane, embed aggregate as specified for new work.
 - b. Cover all membrane areas. Do not leave any exposed membrane surface.
- E. Match existing roofing materials and construction. Use bitumen compatible with existing for roof repair and alteration.
- F. Perform alterations, maintenance and repairs to roof membrane immediately after membrane has been cut or damaged, with permanent new work as specified in this specification. Repair items damaged in surface preparation and aggregate removal.

3.10 ROOF WALKWAYS:

- A. Install roof walkways where shown.
- B. Set prefabricated planks in solid application of cold-applied adhesive. Maintain 75 mm (three inch) to 150 mm (six-inch) space between planks.

3.11 APPLICATION OF COATING

- A. Apply coating on cap sheet and membrane flashings that do not meet solar reflectance requirements.
- B. Apply coating to built-up roofing and base flashings according to manufacturer's written instructions by spray or roller.
- C. Provide dry film thickness of minimum 20 mils (0.5 mm).

3.12 FIELD QUALITY CONTROL

- A. Roofing Inspector: Owner will engage a qualified roofing inspector to perform roof tests and inspections and to prepare test reports.
- B. Roofing Inspector: Contractor shall engage a qualified roofing inspector for a minimum of [5] [7] [10] full-time days on site to perform roof tests and inspections and to prepare start up, interim, and final reports. Roofing Inspector's quality assurance inspections shall comply with criteria established in ARMA/NRCA's "Quality Control Guidelines for the Application of Built-up Roofing."
- C. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.

1. Notify Architect and Owner 48 hours in advance of date and time of inspection.
- D. Repair or remove and replace components of roofing work where test results or inspections indicate that they do not comply with specified requirements.
 1. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.13 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements; repair substrates; and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of acceptance by Owner.
- C. Clean overspray and spillage from adjacent construction. Clean membrane and restore surface to like-new condition meeting solar reflectance requirements.

- - - E N D - - -