

**SECTION 07 51 00
BUILT-UP BITUMINOUS ROOFING**

SPEC WRITER NOTES:

1. Use this section only for NCA projects.
2. Delete text in // // if not applicable to project, or edit to reflect project requirements. Delete other items or paragraphs not applicable and renumber paragraphs.
3. Follow the recommendations of the National Roofing Contractors Association "Roofing and Waterproofing Manual" for design criteria.
4. Insure positive slope to drains occur; minimum of 1:50 (1/4-inch per foot) without any "gutters" (no slopes between drains). Do not use on slopes over 1:12 (one inch per foot) except for flashings. Slope crickets 1:50 (1/4-inch per foot).
5. Insure drains are located at points of maximum deflection; such as at midspans.
6. Assure roof plan shows all penetrations and proper separation of penetrations. Coordinate with plumbing, HVAC, and electrical.
7. Coordinate with Section 07 22 00, ROOF AND DECK INSULATION.
8. Install building expansion joints on curbs 200 mm (8 inches) above roof surface.
9. Do not use pitch pockets.
10. Modify this section to address reroofing of existing roofing system, as applicable.

PART 1 - GENERAL

1.1 DESCRIPTION

- A. This section includes hot-applied bituminous built-up roofing //solar reflective granular coating// //solar reflective aggregate surfacing//.

1.2 RELATED WORK

SPEC WRITER NOTES:

1. Edit Related Work to reflect other sections relating directly to this section or referenced in this section.
- A. Insulating Concrete Systems: Section 03 52 00, LIGHTWEIGHT CONCRETE ROOF INSULATION.
- B. Wood cants, blocking, and wood edge strips: Section 06 10 00, ROUGH CARPENTRY.
- C. Roof Insulation: Section 07 22 00, ROOF AND DECK INSULATION.

- D. Vapor barrier: Section 07 22 00, ROOF AND DECK INSULATION.
- E. Sheet metal components and wind uplift requirements for roof-edge design: Section 07 60 00, FLASHING AND SHEET METAL.
- F. 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 extent referenced. Publications are referenced in text by the basic designation only. Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.

SPEC WRITER NOTES:

1. Remove reference citations that do not remain in Part 2 or Part 3 of edited specification.
2. Verify and make dates indicated for remaining citations the most current at date of submittal; determine changes from date indicated on the TII download of the section and modify requirements impacted by the changes.

- 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):
 - C67/C67M-21 Sampling and Testing Brick and Structural Clay Tile
 - C140/C140M-22b Sampling and Testing Concrete Masonry Units and Related Units
 - C1370-00(2012) Determining the Chemical Resistance of Aggregates for Use in Chemical-Resistant Sulfur Polymer Cement Concrete and Other Chemical-Resistant Polymer Concretes

C1371-15 (2022)	Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers
C1549-16 (2022)	Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer
D146/D146M-04 (2020)	Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing
D312/D312M-16a	Asphalt Used in Roofing
D751-19	Coated Fabrics
D1644-01 (2017)	Nonvolatile Content of Varnishes
D2178/D2178M-15a (2021)	Asphalt Glass Felt Used in Roofing and Waterproofing
D3884-22	Abrasion Resistance of Textile Fabrics (Rotary Platform Double-Head Method)
D3909/D3909M-14 (2021)	Asphalt Roll Roofing (Glass Felt) Surfaced with Mineral Granules
D3960-05 (2018)	Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings
D4073/D4073M-06 (2019) e1	Tensile-Tear Strength of Bituminous Roofing Membranes
D4263-83 (2018)	Indicating Moisture in Concrete by the Plastic Sheet Method
D4586/D4586M-07 (2018)	Asphalt Roof Cement, Asbestos Free
D4601/4601M-04 (2012) e1	Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
D4897/D4897M-16	Asphalt Coated Glass Fiber Venting Base Sheet Used in Roofing
D6511/D6511M-18	Solvent Bearing Bituminous Compounds
E108-20a	Fire Tests of Roof Coverings
E408-13 (2019)	Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
E1918-21	Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field
E1980-11 (2019)	Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field
WK29032	Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer

- 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.
 - 1-29-09 Loss Prevention Data Sheet: Above-Deck Roof Components
 - 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/R13/116-02 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.

SPEC WRITER NOTES:

1. Retain one or more paragraphs below for typical roofing applications based upon current Federal mandates, which may include one or more of the following: 1) Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings incorporated in Executive Order 13423 "Strengthening Federal Environmental, Energy, and Transportation Management, dated January 24, 2007; 2) Energy Policy Act of 2005 (EPA 2005); 3) Energy Independence and Security Act of 2007 (EISA 2007); 4) LEED mandate;

5) Conformance with locally-applicable requirements.

B. 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:

SPEC WRITER NOTES:

1. Retain paragraph below for roofs that must comply with DOE's ENERGY STAR requirements: www.energystar.gov.

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.

SPEC WRITER NOTES:

1. Retain paragraph below for LEED project requirements; note that LEED Credit SS 7.2 is not geographic location specific.

2. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E1980 based on testing identical products by a qualified testing agency.

SPEC WRITER NOTES:

1. Retain paragraph below for roofs that must comply with California Energy Commission CEC-Title 24: www.coolroofs.com.

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.

SPEC WRITER NOTES:

1. Typically retain below for VA new construction and reroofing projects in ASHRAE Climate Zones 1 through 3 and elsewhere where cool roof technology is indicated as cost-effective. Also refer to Exceptions in ASHRAE 90.1 Appendix f that address ballasted, vegetated, and ventilated roofs.

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 90.1-2010 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).

C. VOC Content: Products shall comply with VOC content limits of authorities having jurisdiction unless otherwise indicated.

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 must 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 label on each container or certification with each load of bulk bitumen, indicating Flash Point (FP), Finished Blowing Temperature (FBT), Softening Point (SP), Equiviscous Temperature (EVT).

3. 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.).

SPEC WRITER NOTES:

1. Retain paragraph below when it is appropriate to incorporate Federal Guiding Principles IV from Guiding Principles for Federal Leadership in High Performance and Sustainable Buildings incorporated in Executive Order 13423 "Strengthening Federal Environmental, Energy, and Transportation Management, dated January 24, 2007, www.ofee.gov/eo/eo13423_main.asp: Enhance Indoor Environmental Quality: Biobased Content Requirement. Requirement differs from related requirements in LEED definitions.
2. Project's General Requirements should indicate goals for percentages of bio-based, rapidly renewable, and certified sustainable wood products.

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.

SPEC WRITER NOTES:

1. Retain paragraph below and enter required uplift pressures if roofing system is required to be designed per ASCE/SEI 7 by local building code.
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: //___ kPa/sq. m (___ lbf/sq. ft.)//.
 - b. Perimeter Uplift Pressure: //___ kPa/sq. m (___ lbf/sq. ft.)//.

c. Field-of-Roof Uplift Pressure: //___ kPa/sq. m (___ lbf/sq. ft.)//.

SPEC WRITER NOTES:

- 1. Retain and edit FM Approvals Listing requirement for VA facilities.

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.

SPEC WRITER NOTES:

- 1. Select one option in first subparagraph below based on windstorm classification of project. Utilize calculation based upon FM Approvals Loss Prevention Data Sheet 1-28 to determine the number that establishes the minimum FM approval rating.
- 2. Verify availability of roofing systems that meet these classifications. Other options for classifications increase in increments of 15, e.g., Class 1A-135, 1A-150, 1A-165 and higher.
- 3. "Class 1A" signifies meeting ASTM E108, Class A fire performance for FM-approved Class 1 roof coverings.
- 4. For areas having three or more hailstorms annually, FM recommends roofing systems rated SH (severe hail) instead of MH (moderate hail).

a. Fire/Windstorm Classification: Class 1A-//60// //75// //90// //105// //120//; ASTM E108.

b. Hail Resistance: //MH// //SH//.

SPEC WRITER NOTES:

- 1. Consider retaining requirement below in addition to FM Approval Listing requirement above for high windstorm classification areas (1A-105 or greater) to allow for broader participation in bidding.

6. High Wind Zone Design Requirement: Contractor Option: Instead 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 RE/COR.
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 SUSTAINABILITY REQUIREMENTS

- A. Materials in this section may contribute towards contract compliance with sustainability requirements. See Section 01 81 11, SUSTAINABLE DESIGN REQUIREMENTS, for project // local/regional materials, // low-emitting materials, // recycled content, // certified wood // _____// requirements.
- B. Biobased Material: For products designated by the USDA's BioPreferred® program, provide products that meet or exceed USDA recommendations for biobased content, subject to the products compliance with performance requirements in this Section. For more information regarding the product categories covered by the BioPreferred® program, visit <http://www.biopreferred.gov>.

1.7 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. Protection mat.
- 9. Pavers.
- 10. Application instructions.
- C. Samples:
 - 1. Nails and fasteners, each type.
- D. Shop Drawings: Include plans, sections, details, and attachments.
 - 1. Base flashings and terminations.
 - 2. Nailers and cants.
- E. Certificates:
 - 1. Indicating materials and method of application of roofing system meets requirements of FM Approvals "RoofNav" for specified fire/windstorm classification.

SPEC WRITER NOTES:

- 1. Retain paragraph below when retaining Miami-Dade County requirement under Quality Assurance article above.
 - 2. Indicating compliance with Miami-Dade County requirements.
 - 3. Indicating compliance with load/strain properties requirement.
 - 4. Indicating compliance with energy performance requirement.
- F. Warranty: As specified.
 - G. Documentation of supervisors' and inspectors' qualifications.
 - H. Field reports of roofing inspector.

SPEC WRITER NOTES:

- 1. Retain paragraph below for reroofing projects.
- I. Temporary protection plan. Include list of proposed temporary materials.
 - J. Contract Close-out Submittals:
 - 1. Maintenance Manuals.
 - 2. Warranty signed by installer and manufacturer.

1.8 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.

1.9 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. Protection of interior spaces: Refer to Section 01 00 00, GENERAL REQUIREMENTS.

1.10 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 must comply with VOC limits of authorities having jurisdiction.

SPEC WRITER NOTES:

1. Retain subparagraph below for low-emitting materials required for LEED-NC Credit EQ 4.1 or for general project sustainable design requirements. Below applies to all materials located to interior of weather-proof barrier.
2. Adhesives and sealants that are not on the exterior side of weather barrier must 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. Non-membrane 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. Volatile Organic Compounds (VOC), maximum, ASTM D3960: 65 g/L.
- C. Asphalt: ASTM D312, Type III or IV for roof membrane. Use Type I for pour coat unless specified otherwise.
- 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.

SPEC WRITER NOTES:

1. Retain base sheet below when required as part of system.

B. Base Sheet: ASTM D 4601, Type II, non-perforated, 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: cross machine direction, 12.2 kN/m (70 lbf/in).
2. Pliability, 12.7 mm (1/2 inch) radius bend, ASTM D 146: No failures.

SPEC WRITER NOTES:

1. Retain venting base sheet below when required over a lightweight insulating concrete substrate.

C. Base Sheet, Venting: ASTM D 4897, Type II, venting, non-perforated heavyweight, asphalt-impregnated and coated, glass-fiber base sheet with coarse granular surfacing or embossed venting channels on bottom surface.

SPEC WRITER NOTES:

1. Retain base sheet below when required as part of high tensile strength system.

D. Base Sheet: ASTM D4601, Type II or III, non-perforated, 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 D 4073: 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 D2178, Type VI, heavy-duty ply sheet.
 - 1. Breaking Strength, minimum, ASTM D146: machine direction, 80 lbf/in (14.0 kN/m); cross machine direction, 80 lbf/in (14.0 kN/m).F.
- F. 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.

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

SPEC WRITER NOTES:

- 1. When cap sheet does not meet solar reflectance requirements, select one of two coatings below. Select second coating when required to meet combustibility requirements of authorities having jurisdiction. Note that use of applied coating may introduce owner maintenance requirement on 5-to-7-year basis.
 - 2. Use of cool roof systems need to be examined for cold region climates.
- 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 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.
 - 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/R-93/116: 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.

2.5 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.

2.6 ROOF PAVERS

SPEC WRITER NOTES:

1. Assure pavers are detailed showing size and shape.
2. Use pavers for walkways and around equipment requiring servicing.
3. Pavers are preferred over aggregate ballast, or a combination of pavers and aggregate, and over aggregate only.
4. Do not exceed 600 mm square (24 inches square) for non-interlocking units with approximate weight of 23 kg (50 pounds) each.
5. Interlocking pavers are preferred over non interlocking pavers.
6. Use interlocking type that has been tested in a wind tunnel for wind uplift meeting project requirements
7. Do not use light weight aggregate pavers.
8. Extensive use of pavers is not appropriate for roof systems with solar reflective design requirements.

A. Roof Pavers: Hydraulically pressed, concrete units, with top edges beveled, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:

1. Minimum weight: 73 kg/m² (15 pounds per square foot).

2. Manufactured using normal weight aggregate.
3. Units of size, shape, and thickness as shown.
4. Ribbed on bottom surface or provided with legs approximately 6 mm (1/4 inch) high. Legs must distribute weight of paver so bearing does not exceed 69 kPa (10 psi) on the roofing membrane.
5. Configuration: //Non-Interlocking// //Interlocking//.

SPEC WRITER NOTES:

1. Use pavers for walkways and around equipment requiring servicing.
 2. Pavers are preferred over aggregate ballast, or a combination of pavers and aggregate, and over aggregate only.
- B. Protection Mat: Water pervious; provide a 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.
1. 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.
 2. Edges of fabric selvage or otherwise finished to prevent raveling.
 3. Abrasion resistance: Abrade in conformance with ASTM D3884 using rubber-hose abrasive wheels with one kg load per wheel and 1000 revolutions.
 - a. Result; 25 kg (55 pounds) minimum in any principle direction.
 4. Puncture strength: 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.
 - a. Result; 57 kg (125 pounds) minimum.
 5. 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.
 6. Minimum sheet width: 2400 mm (8 feet).

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, cantos, 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. Test concrete decks for moisture by pouring one pint of hot bitumen at 204 degrees C (400 degrees F.) or EVT on deck at start of each day's Work and at start of each new roof area or plane. Do not proceed if test sample foams or can be easily (cleanly) stripped after cooling.
 - 3. Prime concrete decks, including precast units, with primer as specified. Keep primer back four inches from joints in precast units.
 - 4. 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. 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, bend up cap flashing or temporarily remove cap flashing. Brush and scrape away all deteriorated sheets or surface material of base flashing.

H. Fume Management for Roofing at Occupied Facilities:

1. Use fume recovery system for hot-applied installations when directed by Owner.
2. Operate large fans during placement of hot-applied asphalt to direct airflow away from operating intake louvers.

3.3 HEATING BITUMEN

- A. Heat the asphalt to the equiviscous temperature plus or minus -4 deg. C (25 deg. F) at the time of application:
1. Do not heat asphalt greater than 38 deg. C (100 deg. F) above the equiviscous temperature.
 2. When the equiviscous temperature is not furnished by the asphalt manufacturer, do not heat asphalt above 275 deg. C (525 deg. F) for Type III and IV with temperature not less than 250 deg. C (475 deg. F) at time of application.
- B. Do not heat bitumen above the flash point temperature.
- C. Provide heating kettles with a thermometer kept in operating condition. Attend kettle during heating to insure that the bitumens are heated within the temperatures specified.
- D. Use type III and Type IV asphalt between plies.
- E. Do not mix different type of asphalt in kettle.

3.4 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 RE/COR, 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.

3.5 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 FM 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.

3.6 INSTALLATION OF BUILT-UP BITUMINOUS ROOFING

SPEC WRITER NOTES:

1. Delete substrates and listings of components and quantities which do not apply.
 2. Include the requirement for the base sheet or venting base sheet when roofing is uninsulated. Do not include this requirement when the roof is insulated per 07 22 00 or the substrate is plywood.
- A. Primer: Apply primer to substrates where recommended by roofing manufacturer, in application quantities recommended by roofing manufacturer.
- B. Hot Roofing Asphalt: Apply hot roofing asphalt in quantities required, immediately followed by membrane materials embedded therein before bitumen cools below the application temperature limit.
1. Provide uniform and positive adhesion between all installed materials, including adhesion to insulation or substrate, and between each ply of felt.
 2. Do not apply more material than can be covered at one time except for glaze coats.
 3. Recoat cooled areas.
 4. Do not allow bitumen to penetrate joints or enter building. Provide taped joints where mopping is applied directly to a substrate. When applying steep asphalt, hold mopping back 50mm (2 inches) from each side of joint.
- C. Application Rates:
1. Between substrate and sheets and between plies: 10 to 17.5 kg per 10 sq. m (20 to 35 lbs. per 100 sq. ft.).

2. Glaze coats: 7 to 11 Kg per 10 sq. m (15 to 25 lbs. per 100 sq. ft.).
3. Pour coats: 25 to 30 Kg per 10 sq. m (55 to 65 lbs. per 100 sq. ft.).
4. Provide asphalt quantities within the indicated ranges, unless recommended otherwise in the roofing materials manufacturer's printed data.

D. 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 hot roofing asphalt 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.

SPEC WRITER NOTES:

1. Use venting base sheet over all insulating concrete and poured gypsum decks to relieve possible vapor pressures that may occur.

E. 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. 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.

F. Roof Edges and Terminations:

SPEC WRITER NOTES:

1. Insure details show all wood nailers used in conjunction with roofing and sheet metal components of roofing systems.
 2. Refer to NRCA details 200-MB series for various conditions. Supplemental NRCA details with requirements of FM Approvals PLPDS 1-49, including use of wood cants.
 3. Use cants at vertical surfaces except for pipes.
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. Install strip 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 hot roofing asphalt 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.

SPEC WRITER NOTES:

1. Use base sheet over wood and composite wood decks and where recommended by roofing system manufacturer.

G. Base Sheet Installation:

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

SPEC WRITER NOTES:

1. Use venting base sheet over insulating concrete and poured gypsum decks to relieve vapor pressures.

H. 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.

I. 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.

SPEC WRITER NOTES:

1. Retain and edit paragraph and subparagraphs below when SBS modified bitumen sheet is used as cap sheet.

J. Cap Sheet Installation:

1. Install cap sheet in a solid mopping of hot asphalt.
2. Install cap sheet in a solid application of cold-applied adhesive.
3. 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.

3.7 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.

3.8 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.

3.9 REPAIR AND ALTERATIONS TO EXISTING ROOF

- A. In 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 hot bitumen. 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 hot bitumen 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. Re-strip flanges as specified for new work.
- 6. Resurfacing:
 - a. Embed aggregate over repaired membrane.
 - 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

SPEC WRITER NOTES:

1. Use walkways in the following locations as a minimum:
 2. At working and access areas of equipment requiring servicing.
 3. At equipment having discharges detrimental to roof membrane, under gooseneck discharges from kitchens and chemical exhausts.
 4. At landing points for hatches, ladders and doors entering roof level.
 5. Show extent of walkways and pavers on roof plan.
- 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 INSTALLATION OF PAVERS

SPEC WRITER NOTES:

1. Use pavers in the following locations as a minimum:
 - a. At working and access areas of equipment requiring servicing.

- b. At equipment having discharges detrimental to roof membrane, under gooseneck discharges from kitchens and chemical exhausts.
 - c. At landing points for hatches, ladders and doors entering roof level.
 - 2. Show extent of walkways and pavers on roof plan.
 - 3. Specify pavers and anchorage for pavers when weight of pavers does not meet the requirements for the wind velocities per FM TAB 1-29
 - 4. 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.
 - 5. Use mechanical strapping to create a perimeter anchor, at penetrations, cuts at valleys, over drains and where partial or cut units occur.
 - 6. Detail strapping, perimeter restraints, edge clamps and location of strapping. Do not anchor through base flashing or into cants.
 - 7. Interlocking connectors:
 - a. Use 400 mm (16 inches) on center minimum spacing of connectors.
 - b. Decrease spacing to 300, 200 or 100 mm (12, 8 or 4 inches) on center for higher wind velocities.
- A. 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 unit 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 spacing 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.

3.13 FIELD QUALITY CONTROL

SPEC WRITER NOTES:

1. Select one or both of following two paragraphs based upon project requirements. VA may elect to perform or hire roofing inspector. VA may also elect to require contractor to retain roofing inspector, either as qualified representative of manufacturer or independent third-party inspector.
- 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 must 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 must 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.

3.14 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.

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