UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 51 13

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05/12, CHG 2: 11/18

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USACE / NAVFAC / AFCEC / NASA	**UFGS-07 51 13 (May 2012)**
	Change 2 - 11/18

Preparing Activity: NAVFAC	**Superseding**
	UFGS-07 51 13 (February 2012)

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****

SECTION 07 51 13

BUILT-UP ASPHALT ROOFING
05/12, CHG 2: 11/18

****
NOTE: This guide specification covers the requirements for aggregate surfaced bituminous built-up roofing, and built-up roofing with granule-surfaced modified bitumen cap sheet for existing and new roof systems on slopes from 6 mm to 76 mm 1/4 inch to 3 inches per foot.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: The requirements for hot-mopped, four-ply, aggregate surfaced, built-up bituminous roofing systems and built-up bituminous roof systems consisting of three-ply felts and granule-surfaced modified bitumen cap sheet are included in this guide specification. This guide specification does not include the structural roof deck, insulation, or sheet metal fascias, gravel stops, and flashings.

Coordinate this section with other roof system components specifications such as rough carpentry, insulation and sheet metal flashing. Also coordinate this section with the criteria contained

in UFC 3-110-03 "Roofing", as it relates to the specific project and Service Exceptions indicated therein.

NOTE: In most cases, use aggregate surfacing or granule surfaced modified bitumen cap sheet surfacing in lieu of smooth surfaced built-up roofs. Generally, when properly applied and maintained, aggregate surfaced roofing will have greater life expectancy. Consider granulated cap sheet surfacing where:

1. There is danger of aggregate being drawn into air intakes of jet aircraft.

2. There is danger of wind blown aggregate jeopardizing property and life safety.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

NOTE: Select one of the following references subject to design criteria and the particular materials selected for the application and remove the other two references sited below within the body of the text citing the applicable reference:

[ASTM D4869] [ASTM D6757/D6757M] [ASTM D1970/D1970M]

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN SOCIETY OF CIVIL ENGINEERS (ASCE)

ASCE 7-16 (2017; Errata 2018; Supp 1 2018) Minimum

	Design Loads and Associated Criteria for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM C208	(2022) Standard Specification for Cellulosic Fiber Insulating Board
ASTM C728	(2017a; R 2022) Standard Specification for Perlite Thermal Insulation Board
ASTM C1153	(2010; R 2015) Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
ASTM D41/D41M	(2011; R 2016) Standard Specification for Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D312/D312M	(2016a) Standard Specification for Asphalt Used in Roofing
ASTM D448	(2012; R 2017) Standard Classification for Sizes of Aggregate for Road and Bridge Construction
ASTM D517	(1998; R 2008) Asphalt Plank
ASTM D1863/D1863M	(2005; R 2011; E 2012) Mineral Aggregate Used on Built-Up Roofs
ASTM D1864/D1864M	(1989; E 2009; R 2009) Moisture in Mineral Aggregate Used on Built-Up Roofs
ASTM D1970/D1970M	(2019) Standard Specification for Self-Adhering Polymer Modified Bituminous Sheet Materials Used as Steep Roofing Underlayment for Ice Dam Protection
ASTM D2170/D2170M	(2018) Standard Test Method for Kinematic Viscosity of Asphalts (Bitumens)
ASTM D2178/D2178M	(2015a; R 2021) Standard Specification for Asphalt Glass Felt Used in Roofing and Waterproofing
ASTM D3617	(2007; R 2015; E 2015) Sampling and Analysis of New Built-Up Roof Membranes
ASTM D4263	(1983; R 2018) Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method
ASTM D4402/D4402M	(2015) Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
ASTM D4586/D4586M	(2007; R 2018) Asphalt Roof Cement, Asbestos-Free

ASTM D4601/D4601M	(2004; R 2020) Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing
ASTM D4637/D4637M	(2015) EPDM Sheet Used in Single-Ply Roof Membrane
ASTM D4869/D4869M	(2016a) Standard Specification for Asphalt-Saturated Organic Felt Underlayment Used in Steep Slope Roofing
ASTM D4897/D4897M	(2016) Standard Specification for Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
ASTM D6162/D6162M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements
ASTM D6163/D6163M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
ASTM D6164/D6164M	(2016) Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
ASTM D6757/D6757M	(2018) Standard Specification for Underlayment Felt Containing Inorganic Fibers Used in Steep-Slope Roofing
ASTM E108	(2020a) Standard Test Methods for Fire Tests of Roof Coverings

FM GLOBAL (FM)

FM 4470	(2022) Single-Ply, Polymer-Modified Bitumen Sheet, Built-up Roof (BUR), and Liquid Applied Roof Assemblies for Use in Class 1 and Noncombustible Roof Deck Construction
FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RoofMan	(2020) The NRCA Roofing Manual

SINGLE PLY ROOFING INDUSTRY (SPRI)

ANSI/SPRI RD-1	(2019) Performance Standard for Retrofit Drains

U.S. DEPARTMENT OF ENERGY (DOE)

Energy Star	(1992; R 2006) Energy Star Energy Efficiency Labeling System (FEMP)

UNDERWRITERS LABORATORIES (UL)

UL 790	(2022) UL Standard for Safety Test Methods for Fire Tests of Roof Coverings
UL RMSD	(2012) Roofing Materials and Systems Directory

1.2 DESCRIPTION OF ROOF MEMBRANE SYSTEM[S]

****
NOTE: Coordinate requirements with Part 2 materials specification. Delete the bracketed option not applicable to the project.
****

Asphalt applied, [four-ply felt, aggregate surfaced][three-ply felt with granule-surfaced modified bitumen cap sheet] built-up roof membrane system.

1.3 SUBMITTALS

****
NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force,

and NASA projects, or choose the second bracketed item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-03 Product Data

Wind Uplift Calculations; G[, [_____]]

Asphalt

Felts, including ply felt, base sheet and ventilating felt as applicable; G[, [_____]]

[Granule Surface Modified Bitumen Cap Sheet; G[, [_____]]

][Heat Island Reduction; S

][Energy Star Label for Top Coating Product; S

] Flashing Membrane; G[, [_____]]

Fasteners

Primer

Asphalt Roof Cement

Walkpad Materials

Cant Strips

Certificate attesting that the fiberboard furnished for the project contains recovered material, and showing an estimated percent of such recovered material.

Pre-Manufactured Accessories to be incorporated in the system installation; G[, [_____]]

Roof Walkways

Sample Warranties certificates; G[, [_____]]

Submit all data required with requirements of this section. Include in Data written acceptance by the roof membrane manufacturer of the products and accessories provided. List products in the applicable wind uplift and fire rating classification listings, unless approved otherwise by the Contracting Officer.

SD-06 Test Reports

Samples of Built-Up Roofing

Submit test results on roofing field samples as required, verifying composition of sample. Submit six copies of laboratory analysis within 30 calendar days after samples are taken. Submit reports in accordance with ASTM D3617.

SD-07 Certificates

Bill of Lading

Submit when labels of asphalt containers do not indicate the finished blowing temperature, flash point and equiviscous temperature.

Qualifications of Applicator

Submit evidence of the roofing system manufacturer's approval.

SD-08 Manufacturer's Instructions

****
NOTE: Edit the manufacturers instructions submission requirements as necessary for the system specified. Include bracketed requirements only as applicable to the system being specified.
****

Felts; G[, [_____]]

Flashings; G[, [_____]]

[Modified Bitumen Cap Sheet; G[, [_____]]

Base Sheet attachment, including pattern and frequency of mechanical attachments required in field of roof, corners, and perimeters to provide for the specified wind resistance.

] Asphalt

Primer

Roof Cement

Fasteners

Cold Weather Conditions installation; G[, [_____]]

Include detailed application instructions and standard manufacturer drawings altered as required by these specifications.[Include membrane manufacturer requirements for nailers and backnailing of roof membrane on steep slopes.] Explicitly identify in writing, differences between manufacturer's instructions and the specified requirements.

SD-11 Closeout Submittals

Warranty

Information Card

1.4 QUALITY ASSURANCE

****

NOTE: All projects with more than 1400 square meters 15,000 square feet of roof area or that is defined as critical use or mission critical in the project DD Form 1391 must have a Registered Roof Consultant (RRC) or a registered professional engineer (PE) or registered architect (RA) that derives his or her principal income from roofing design on the quality control staff of the design team.

****

1.4.1 Qualifications of Applicator

The roofing system applicator must be approved, authorized, or licensed in writing by the roofing system manufacturer and must have a minimum of 3 years experience as an approved, authorized, or licensed applicator with the manufacturer and be approved at a level capable of providing the specified warranty.

1.4.2 [Qualifications of Photovoltaics (PV) Rooftop Applicator

The PV rooftop applicator must be approved, authorized, or certified by a Roof Integrated Solar Energy (RISE) Certified Solar Roofing Professional (CSRP), and comply with applicable codes, standards, and regulatory requirements to maintain the weatherproofing abilities of both the integrated roof system and photovoltaic system.

]1.4.3 Fire Resistance

Complete roof covering assembly must:

****

NOTE: Specify Class B option only when Class A may not be attainable such as membrane system application directly to wood deck. Provide justification/rationale for Class B option with design submission

****

a. Be Class A rated in accordance with ASTM E108 , FM 4470, or UL 790; and

b. Be listed as part of Fire-Classified roof deck construction in UL RMSD, or Class I roof deck construction in FM APP GUIDE.

1.4.4 Wind Uplift Resistance

****

NOTE: Determine the required wind uplift resistance based on ASCE 7-16 wind loading calculations or applicable building code requirements. The specified FM rating incorporates a safety factor of 2 over the maximum calculated uplift pressure. Therefore, a FM rating of 1-90 correlates to a maximum uplift calculation of 2.2kPa 45 psf. When a rated system is specified, ensure the specified roof system is capable of meeting the wind uplift

resistance specified. Utilize commercially available sources such as Factory Mutual Roofnav https://www.roofnav.com to validate wind uplift rated systems. Use ASCE-7 for determining uplift requirements. Where non-rated systems may be permissible, or rated systems cannot be obtained such as a reroof, ensure that validated wind uplift calculations and substantiating data are provided by a licensed engineer.

Delineate calculated values in the roof specification and drawings. Utilize independently tested and rated roof systems, such as Factory Mutual (FM), Underwriters Laboratories (UL), and Single Ply Roofing Industry (SPRI).
****

Provide a complete roof system assembly that is rated and installed to resist wind loads [indicated][calculated in accordance with ASCE 7-16] and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Do not install non-rated systems except as approved by the Contracting Officer. Submit licensed engineer's wind uplift calculations and substantiating data to validate any non-rated roof system. Base wind uplift measurements on a design wind speed of[_____] km/h [_____] mph in accordance with ASCE 7-16 and other applicable building code requirements.

1.4.5 Preroofing Conference

After approval of submittals and before performing roofing [and insulation] system installation work, hold a preroofing conference to review the following:

a. Drawings and specifications and submittals related to the roof work;

b. Roof system components installation;

c. Procedure for the roof manufacturer's technical representative's onsite inspection and acceptance of the roofing substrate, the name of the manufacturer's technical representatives, the frequency of the onsite visits, distribution of copies of the inspection reports from the manufacturer's technical representatives to roof manufacturer;

d. Contractor's plan for coordination of the work of the various trades involved in providing the roofing system and other components secured to the roofing; and

e. Quality control plan for the roof system installation;

f. Safety requirements.

Coordinate preroofing conference scheduling with the Contracting Officer. The conference must be attended by the Contractor, the Contracting Officer's designated personnel, and personnel directly responsible for the installation of roofing[and insulation], flashing and sheet metal work,[[mechanical][and][electrical] work,] other trades interfacing with the roof work,[Fire Marshall,] and a representative of the roofing materials manufacturer. Before beginning roofing work, provide a copy of meeting notes and action items to all attending parties. Note action items

requiring resolution prior to start of roof work.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver materials in manufacturers' original unopened containers and rolls with manufacturer's labels intact and legible. Mark and remove wet or damaged materials from site. Where materials are covered by a referenced specification, container must bear specification number, type, and class, as applicable. Indicate on labels or bill of lading for roofing asphalt the asphalt type, finished blowing temperature (FBT), flash point (FP), and equiviscous temperature (EVT), that is, the temperature at which the viscosity is either 125 centistokes when tested in accordance with ASTM D2170/D2170M or 75 centipoise when tested in accordance with ASTM D4402/D4402M. Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.5.2 Storage

Protect materials against moisture absorption, contamination, or other damage. Avoid crushing or crinkling of roll materials. Store roll materials on end on clean raised platforms in dry locations in enclosed buildings or trailers with adequate ventilation. Do not store roll materials in buildings under construction until concrete, mortar, and plaster work are finished and dry. Do not store materials outdoors unless approved by the Contracting Officer. Completely cover felts stored outdoors, on and off roof, with waterproof canvas protective covering. Do not use polyethylene sheet as a covering. Tie covering securely to pallets to make completely weatherproof and yet provide sufficient ventilation to prevent condensation. Maintain roll materials at temperature above 10 degrees C 50 degrees F for a 24-hour period immediately prior to application. Keep aggregate dry as defined by ASTM D1863/D1863M. Place only those materials to be used during one day's work on the roof at one time. Remove unused materials from the roof at the end of each day's work. Immediately remove wet, contaminated or otherwise damaged or unsuitable materials from the site. Damaged materials may be marked by the Contracting Officer.

1.5.3 Handling

Prevent damage to edges and ends of roll materials. Do not install damaged materials in the work. Select and operate material handling equipment so as not to damage materials or applied roofing.

1.6 ENVIRONMENTAL CONDITIONS

Do not install roofing during precipitation, or fog, or when air temperature is below 4 degrees C 40 degrees F, or when there is ice, frost, moisture or visible dampness on roof deck.[Restriction on application of roofing materials below 4 degrees C 40 degrees F may be waived if Contractor devises a means, satisfactory to Contracting Officer, of: (1) maintaining surrounding temperature above 4 degrees C 40 degrees F; (2) maintaining application temperature of heated materials without exceeding maximum specified heating temperature; and follows other recommendations of the membrane manufacturer for application in cold weather conditions.]

1.7 SEQUENCING

Coordinate the work with other trades to ensure that components which are to be secured to or stripped into the roofing system are available and that permanent flashing and counterflashing are installed as the work progresses. Ensure temporary protection measures are in place to preclude moisture intrusion or damage to installed materials.[Install roofing immediately following application of insulation as a continuous operation. Coordinate roofing operations with insulation work so that all roof insulation applied each day is covered with complete felt ply installation the same day.]

1.8 WARRANTY

Provide roof system material and workmanship warranties meeting specified requirements. Provide revision or amendment to standard membrane manufacturer warranty to comply with the specified requirements. Provide a manufacturer's warranty that has no dollar limit, covers full system water-tightness and has a minimum duration of 20 years.

1.8.1 Roof Membrane Manufacturer Warranty

****

NOTE: Buildings with roof area of 700 sq. meters 7535 sq. feet 75 squares or greater, administrative, classroom and other high use facilities, and facilities with sensitive use, contents, equipment, or functions require minimum 20 year warranty. All environmentally controlled interiors require a minimum 10 year roof warranty. Designer may specify 5 or 10 year manufacturer warranty on facilities of small roof area and of minor importance where interiors and contents are not severely impacted by water.

****

Furnish the roof membrane manufacturer's 20-year no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation, and accessories necessary for a watertight roof system construction. Write the warranty directly to the Government commencing at the time of Government's acceptance of the roof work. Provide the following statements for such warranty:

a. If within the warranty period the roof system, as installed for its intended use in the normal climatic and environmental conditions of the facility, becomes non-watertight, shows evidence of moisture intrusion within the assembly, blisters, splits, tears, delaminates, separates at the seams, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged materials of the roof system assembly and correction of defective workmanship are the responsibility of the roof membrane manufacturer. All costs associated with the repair or replacement work are the responsibility of the roof membrane manufacturer.

b. The warranty remains in full force and effect, including emergency temporary repairs performed by others, when the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification.

1.8.2 Roofing System Installer Warranty

The roof system installer must warrant for a minimum period of two years that the roof system, as installed, is free from defects in installation workmanship, to include the roof membrane, flashing, insulation, accessories, attachments, and sheet metal installation integral to a complete watertight roof system assembly. Write the warranty directly to the Government. The roof system installer is responsible for correction of defective workmanship and replacement of damaged or affected materials. The roof system installer is responsible for all costs associated with the repair or replacement work.

1.8.3 Continuance of Warranty

Approve repair or replacement work that becomes necessary within the warranty period and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the roof membrane manufacturer warranty for the remainder of the manufacturer warranty period.

1.9 CONFORMANCE AND COMPATIBILITY

Provide the entire roofing and flashing system in accordance with specified and indicated requirements, including fire and wind resistance requirements. Work not specifically addressed and any deviation from specified requirements must be in general accordance with recommendations of the NRCA RoofMan, membrane manufacturer published recommendations and details, and compatible with surrounding components and construction. Submit any deviation from specified or indicated requirements to the Contracting Officer for approval prior to installation.

1.10 ELIMINATION, PREVENTION OR CONTROL OF FALL HAZARDS

****

NOTE: Any part or component of the building, facility, structure, or equipment requiring future maintenance work must incorporate in the design fall prevention methods or techniques to eliminate fall hazards, in accordance with ANSI/ASSE A1264.1. Fall prevention methods may include identifying, designing, and installing anchorages (hard points) for safe use of fall arrest equipment and systems. Select the materials to be used for metal compatibility in order to minimize corrosion, type 316 stainless steel is recommended.

****

1.10.1 Fall Protection

[_____]

PART 2 PRODUCTS

****

NOTE: Edit the materials specification requirements as necessary for the system(s) specified in PART 1 - DESCRIPTION OF ROOF MEMBRANE SYSTEM.

See the Note in PART 1 - DESCRIPTION OF ROOF MEMBRANE SYSTEM for useful information in editing the membrane materials requirements.

Include bracketed requirements only as applicable to the system being specified (e.g., torch applied systems may not require asphalt in the installation; granule surfaced cap sheets do not require gravel or coating surfacing).

****

2.1 GENERAL

Furnish a combination of specified materials that comprise the membrane manufacturer's standard system of the number and type of plies specified. Provide materials approved by the roof membrane manufacturer and suitable for the service and climatic conditions of the installation.

2.1.1 Energy [and Cool Roof] Performance

****

NOTE: Standards such as UFC 1-200-02 promote the use of cool roofing, and increased energy conservation through additional insulation. Design cool roofs in accordance with the requirements in UFC 3-110-03 "Roofing" Chapter 1, Cool Roofs. Consider that when cool roofing is used with insulation R values greater than 24, the 'cool roof' surface has little if no influence on the energy performance of the building. Additionally, designers should be aware of the possible negative impacts of using cool roofing that may result in unintended consequences. Condensation on the underside of mechanically-fastened systems can result in ice build-up in winter, mold growth on the facers, moisture dripping into the interior, and replacement of the roofs with less than four years of service. See Appendix B of UFC 3-110-03 for more information. Inadequate design of cool roofs in ASHRAE climate zones 4 and higher have resulted in the unintended consequence of condensation below the membrane-a result of the material's inability to warm and drive moisture downward. Roofs that experience this condensation have had to be replaced. Other unintended consequences include the overheating of masonry walls, interior spaces, roof top piping and mechanical equipment as a result of the reflected UV rays.

NOTE: Designer to specify the roof performance by R-Value on the drawings or stated in other specification sections.

****

****

NOTE: Facilities with dominant cooling loads or in mild or warm climate zones are required to meet "cool roofing" requirements of FEMP. Design cool roofs in accordance with the requirements in UFC

3-110-03 Roofing, Appendix B and ASHRAE 90.1 Chapter 5, for insulation and energy performance of the building.

NOTE: If a cool roof is not selected in ASHRAE zones 1 thru 3, design must meet one of the exception requirements listed in ASHRAE 90.1 Chapter 5 or provide thermal insulation above the deck with an R value of 33 or greater. Coordinate these requirements with insulation design and specifications.

Retain the next to last bracketed note for project with cool roof requirement. Retain the last bracketed sentence for project with sustainable third party certification credit requirement for reduced heat island effect.

****

Install a roof system that meets an overall performance as specified on the drawings or by insulation specified in other sections.[The roofing system will need to include a top surface finish that meets the criteria for Cool Roof Products.[Provide emittance and reflectance percentages, solar reflectance index values,[and]slopes [_____], to meet sustainable third party certification requirements for Heat Island Reduction.]]

2.2 FIBERGLASS FELT MATERIALS

****

NOTE: Select the base sheet option required and delete other base sheet options. Base sheets under insulation should be specified in the insulation specification section.

Perforated venting base sheet option should only be specified for application directly on concrete deck. Base sheets with perforations are rolled into place and then top mopped with hot asphalt. Base sheets without perforations are mechanically attached to nailable substrates.

****

[a. Venting Base Sheet: ASTM D4897/D4897M, Type II, [without][with] perforations and as approved by the roof membrane manufacturer.

][b. Fiberglass Felt Base Sheet: ASTM D4601/D4601M, Type II, [without][with] perforations and as approved by the roof membrane manufacturer.

] c. Ply Felt: ASTM D2178/D2178M, Type [IV][or][VI].

2.3 BASE FLASHING MEMBRANE

ASTM D6163/D6163M. Membrane manufacturer's standard, minimum two-ply modified bitumen membrane flashing system compatible with the built-up roof membrane and as recommended in membrane manufacturer's published literature. Provide a minimum base ply of flashing membrane of 1.8 mm 70 mils thick. Provide a minimum granule surface modified bitumen flashing cap sheet of 3 mm 120 mils thick on the selvage edge.

2.4 ASPHALT

****

NOTE: Specify asphalt type based on roof slope. Adhere to the following general requirements:

Roof Slope, mm/m in./ft	Type Asphalt
Less than 25 Less than 1/2	Type II, Type III in hot climate
25 to 50 1/2 to 1	Type III
50 to 75 1 to 1-1/2	Type III, Type IV in hot climate

In locations where ambient temperature frequently exceeds 38 degrees C 100 degrees F and roof slope is 15 mm 1/2 inch per foot or greater, specify Type IV asphalt.

****

ASTM D312/D312M, Type [II] [or] [III] [or] [IV], in accordance with membrane manufacturer requirements and compatible with the slope conditions of the installation.

2.5 SURFACING MATERIAL

****

NOTE: Do not use coral as a gravel surface in humid locations or project locations with Environmental Severity Classifications (ESC) of C3 thru C5. Coral usually blackens with algae and deteriorates, becoming a growth medium for sprouting seeds. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). See UFC 1-200-01 for determination of ESC for project locations.

****

[2.5.1 Aggregate for Surfacing Built-up Roofing

Water-worn gravel, crushed stone, or crushed slag, conforming to ASTM D1863/D1863M, or marble, expanded slag, or expanded shale, conforming to ASTM D1863/D1863M except density not less than 880 kg per cubic meter 55 pcf. Aggregate conforming to gradation sizes No. 6, No. 7, and No. 67 in conformance with ASTM D448 is acceptable provided other requirements of ASTM D1863/D1863M are met. Provide 2 percent maximum moisture content as determined by ASTM D1864/D1864M. Provide light colored and opaque aggregate. Limestone, volcanic rock, crushed shells, and cinders are prohibited.

][2.5.2 Granule Surface Modified Bitumen Cap Sheet

****

NOTE: Do not use gravel surface cap sheet in humid

locations or project locations with Environmental Severity Classifications (ESC) of C4 and C5. See UFC 1-200-01 for determination of ESC for project locations. Humid locations are those in ASHRAE climate zones 0A, 1A, 2A, 3A, 3C, 4C and 5C (as identified in ASHRAE 90.1). Use a reflective mineral surfaced cap sheet system or a reflective coated smooth surface system.

****

****

NOTE: Specify ASTM D6163/D6163M, fiberglass reinforced cap sheet, as a standard cap sheet. Also may include the alternate for ASTM D6162/D6162M cap sheet, combination fiberglass and polyester. For high puncture resistance and for high traffic roofs, specify ASTM D6164/D6164M only (polyester reinforced cap sheet).

****

[ASTM D6163/D6163M][ASTM D6162/D6162M][ASTM D6164/D6164M]; Type II, Grade G, minimum 3 mm (120 mils) thick at selvage edge, and as required to provide specified fire safety rating.

]2.6 PRIMER

ASTM D41/D41M for asphalt roofing systems and as approved by the membrane manufacturer.

2.7 ASPHALT ROOF CEMENT

ASTM D4586/D4586M for use with asphalt roofing systems, Type II for vertical surfaces and built-up bituminous flashings; Type I for horizontal surfaces and as recommended by the membrane manufacturer.

2.8 CANT STRIPS

****

NOTE: Use wood cant in non-supported flashing and wood blocking details (i.e., expansion joints, area dividers, and wall/roof intersections where roof deck is not supported by a wall).

****

Provide standard perlite cant strips conforming to ASTM C728[or wood fiber conforming to ASTM C208] treated with bituminous impregnation, sizing, or waxing and fabricated to provide maximum 45 degree change in direction of membrane. Provide minimum 38 mm 1-1/2 inch thick cant strips and provide for minimum 125 mm 5 inch face and 89 mm 3-1/2 inch vertical height when installed at 45 degree face angle, except where clearance restricts height to lesser dimension.

2.9 UNSATURATED FELT OR ROSIN-SIZED BUILDING PAPER

****

NOTE: Include requirement for unsaturated felt or rosin-sized building paper under base sheet on wood decks substrates to prevent bitumen drippage through deck joints.

****

Provide rosin-sized sheathing paper weighing minimum 3 kilogram per 10 square meter 5 pounds per 100 square feet or unsaturated felt weighing approximately 3.7 kilogram per 10 square meter 7-1/2 pounds per 100 square feet.

2.10 FASTENERS AND PLATES

Coated, corrosion resistant fasteners compatible with components being attached and contact surfaces. Conform to FM 4470 for fasteners for attachment to deck substrate of Class I roof deck construction and FM APP GUIDE for the wind resistance specified. Use hard copper fasteners in contact with copper; aluminum or stainless steel fasteners in contact with aluminum; and stainless steel fasteners in contact with stainless steel. For fastening only roofing felts, use fasteners driven through metal discs, or one-piece composite fasteners with heads not less than 25 mm 1 inch in diameter or 25 mm 1 inch square with rounded or 45-degree tapered corners.

[2.10.1 Wood Substrates and Nailers

Provide 11 gage annular threaded shank nails with 7/16 to 5/8 inch diameter heads; or one-piece composite nails with annular threaded shanks not less than 11 gage for securing felts and metal items. Provide fasteners long enough to penetrate minimum 25 mm 1 inch into or minimum 6 mm 1/4 inch through wood substrate materials. Do not penetrate wood decking exposed to view on the underside.

][2.10.2 Masonry or Concrete Walls and Vertical Surfaces

Provide hardened steel nails or screws with flat heads, diamond shaped points, and mechanically deformed shanks not less than 25 mm 1 inch long for securing felts, metal items, and accessories. Use power-driven fasteners only when approved in writing by Contracting Officer.

]2.10.3 Metal Plates

Flat corrosion-resistant round stress plates as recommended by the modified bitumen sheet manufacturer's printed instructions and meeting the requirements of FM 4470; minimum 50 mm 2 inch in diameter. Form discs to prevent dishing or cupping.

[2.11 PRE-MANUFACTURED ACCESSORIES

****

NOTE: Edit, delete, and insert accessory materials requirements as required for the specific project and components to be installed.

****

Pre-manufactured accessories must be manufacturer's standard for intended purpose,[comply with applicable specification section,] compatible with the membrane roof system and approved for use by the roof membrane manufacturer.

[2.11.1 Pre-fabricated Curbs

Provide [_____] gauge [G90 galvanized][AZ55 galvalume][_____] curbs with

minimum 100 mm 4 inch flange for attachment to roof nailers. Provide minimum height of 250 mm 10 inch above the finished roof membrane surface.

][2.11.2 Photovoltaic (PV) Systems - Rack Mounted Systems

****

NOTE: The installation of a PV roof system over existing roof systems should be undertaken with extreme caution. Do not install PV systems on roofs with a shorter expected service life than the new PV system. Prior to the design of such systems the following must be undertaken:

a. Determine if the existing roof structure can handle the anticipated roof load increase.

b. Inspect and determine that the existing roof system has at least 10 years of service life remaining. If not, remove the existing roof and provide a new replacement roof system design in tandem with the photovoltaic system.

c. If 10 years remaining service life remains, ensure the design of the intersecting details, required roof protection, re-inspections, and warranty requirements for maintaining the roof system has been coordinated with theinstallation and manufacturers' warranties.

d. Design the roof related details for anticipated roof replacement work. Coordinate with the PV system designer to anticipate and plan for future roof replacement.

e. PV equipment on a rooftop creates additional roof protection requirements during initial installation and throughout the PV life-cycle. Ensure a roof protection program is specified during the PV system installation.

f. Permanenetly affix PV supports to stanchions which are anchored to the building structure.

****

Adhere to the following guidelines:

a. *Building Owners Guide to Roof-mounted PV Systems*, published by NRCA.

b. *Guidelines for Roof-Mounted PV Systems*, published by NRCA.

]][2.12 WALKPADS

****

NOTE: Use walkpads or walkways at roof access points and where the roof or areas of the roof are intended to bear foot traffic for maintenance or other purposes once a month or more frequently.

****

Provide polyester reinforced roof walkpads, granule-surfaced modified bitumen membrane material, ASTM D6162/D6162M or ASTM D6164/D6164M, minimum [_____] 5 mm [_____][200] mils thick, compatible with the roof membrane and as recommended by the roof membrane manufacturer. Do not exceed 1.2 meters 4 feet in length for each panel. Other walkpad materials require approval of the Contracting Officer prior to installation.

2.12.1 ROOF WALKWAYS

Provide 950 by 1830 millimeter by 15 millimeter 36 by 72 inch by 1/2 inch thick asphalt planks, consisting of a homogeneous core of asphalt, plasticizers, and fillers bonded between two saturated and coated facing sheets. Top side must be surfaced with ceramic granules. Conform to ASTM D517, mineral-surfaced asphalt.

][2.13 PAVER BLOCKS

****
NOTE: Use concrete pavers as walkways on aggregate surface roofs where the roof or areas of the roof are intended to bear foot traffic for maintenance or other purposes once a month or more frequently. Use paver blocks under heavy bearing components, irregular base bearings and for support and attachment of lightweight pipe, conduit, and drainage lines routed along roof surface.
****

Precast concrete, minimum 38 mm 1-1/2 inch thick, minimum 450 mm 18 inch square for walkways and minimum 150 mm by 300 mm 6-inch by 12-inch for use in supporting surface bearing components but extending not less than 50 mm 2 inch beyond all sides of surface bearing bases. Install walkpad material under all paver blocks.

][2.14 ROOF INSULATION BELOW MEMBRANE SYSTEM

****
NOTE: If the roofing system contains insulation, coordinate with the appropriate insulation specification section. The insulation specification should include materials and installation up to the substrate on which the roof membrane base sheet and or membrane layers are to be installed. Coordinate base sheet attachment (mechanically fastened or mopped) with FM or UL fire and wind uplift requirements.
****

Provide insulation compatible with the roof membrane, approved by the membrane manufacturer.

]2.15 MEMBRANE LINER

Self-adhering modified bitumen underlayment conforming to ASTM D1970/D1970M, EPDM membrane liner conforming to ASTM D4637/D4637M, or other waterproof membrane liner material conforming to ASTM D4869/D4869M, or ASTM D6757/D6757M, and as approved by the Contracting Officer.

[2.16 TOP COATING

****

NOTE: Top coatings can provide Energy Star classification when applied as final surface. Typical colors are white, tan, and other light colors. In review of the overall performance of the roof, color and materials specified earlier in this specification, the designer has the option to include Energy Star rating by including the paragraph below.

****

Provide a top coating product that is Energy Star labeled and is produced and compatible with the roof material of this specification. Provide data identifying Energy Star label for top coating product. Install to the manufacturer's written installation methods. Provide written confirmation that installation of a top coat will not modify or void the required roof warranty.

]PART 3 EXECUTION

3.1 VERIFICATION OF CONDITIONS

Before applying roofing materials, ensure that the following exist:

a. Do not install items that show visual evidence of biological growth.

b. [Drains,] [curbs,] [cants,] [control joints,] [expansion joints,] [perimeter walls,] [roof penetrating components,] [and] [equipment supports] are in place.

c. Surfaces are rigid, clean, dry, smooth, and free of cracks, holes, and sharp changes in elevation. Joints in substrate are sealed to prevent drippage of bitumen into building or down exterior walls. Inspect surfaces and approve immediately before application of roofing and flashings. Apply the roofing and flashings to a smooth and firm surface free from ice, frost, visible moisture, dirt, projections, and foreign materials.

d. The plane of the substrate does not vary more than 6 mm 1/4 inch within an area 3 by 3 meters 10 by 10 feet when checked with a 3 meter 10 foot straight edge placed anywhere on the substrate.

e. Substrate is sloped as indicated to provide drainage.

f. Walls and vertical surfaces are constructed to receive counterflashing and will permit mechanical fastening of the base flashing materials.

g. Treated wood nailers are in place on non-nailable surfaces, to permit nailing of base flashing at minimum height of 8 inch above finished roofing surface.

****

NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY to ensure that waterborne preservative treatment is specified for wood which will be in contact with roofing components.

****

h. Treated wood nailers are fastened in place at eaves, gable ends, openings, and intersections with vertical surfaces for securing of felts, edging strips, attachment flanges of sheet metal, and roof fixtures.[Embedded nailers are flush with deck surfaces.][Surface-applied nailers are same thickness as roof insulation.]

****

NOTE: Wood cants should also be used where there are non-wall supported flashings at wood blocking forming area dividers and expansion joints, and at wall and roof intersections where roof deck is not supported on wall.

****

i. Cants are securely fastened in place in the angles formed by walls and other vertical surfaces. The angle of the cant is approximately 45 degrees and the height of the vertical leg is not less than nominal 89 mm 3-1/2 inch. Lay cants in a solid asphalt mopping or coat of asphalt cement just prior to laying the roofing plies.

****

NOTE: Include venting provision for wet fill substrate materials like lightweight cellular concrete.

****

[j. Venting is provided in accordance with the following:

[(1) Edge Venting: Perimeter nailers are kerfed across width of the nailers to permit escape of gaseous pressure at roof edges.

][(2) Underside Venting: Vent openings are provided in steel form decking for cast-in-place concrete substrate.

]]

****

NOTE: Coordinate with Section 06 10 00 ROUGH CARPENTRY, to ensure that waterborne preservative treatment is specified for wood which will be in contact with roofing components.

****

[k. Exposed nail heads in wood substrates are properly set. Warped and split [boards][sheets] have been replaced. There are no cracks or end joints 6 mm 1/4 inch in width or greater. Knot holes are covered with sheet metal and nailed in place. [Wood][Plywood] decks are covered with rosin paper or unsaturated felt prior to base sheet or roof membrane application.[Joints in plywood substrates are taped with 50 mm 2 inch wide masking tape to prevent air leakage from the underside.]

][l. Insulation boards are installed smoothly and evenly, and are not broken, cracked, or curled. There are no gaps in insulation board joints exceeding 6 mm 1/4 inch in width. Insulation is being roofed over on the same day the insulation is installed.

] m. [Cast-in-place concrete substrates have been allowed to cure and the surface dryness requirements specified under paragraph FIELD QUALITY CONTROL have been met.]No viable moisture present when conducting

ASTM D4263.

n. [Joints between precast concrete deck units, including weld plates, are grouted, leveled, and covered with 4 inch wide ply felt or other bituminous stripping membrane set in bituminous cement prior to applying other roofing materials over the area.]Prior to application of primer on precast concrete decks, cover joints with a minimum 100 mm 4 inch strip of felt or bituminous stripping membrane set in bituminous cement.

3.1.1 Summary Of Minimum Material Weights (Per 10 sq meter 100 sq ft)

Asphalt assembly:

[Sheathing paper] [Base sheet]	[_____kg] [_____pounds]
[Asphalt mopping] [Adhesive] to receive insulation	[_____kg] [_____pounds]
Vapor retarder	[_____kg] [_____pounds]
Roof insulation	[_____kg] [_____pounds]
Asphalt mopping to receive base sheet	[_____kg] [_____pounds]
Asphalt-saturated roofing felts ed roofing felts	[_____kg] [_____pounds]
Asphalt moppings between felts ([_____] at [_____] kg) pounds)	[_____kg] [_____pounds]
Cap sheet	[_____kg] [_____pounds]
Flood coat	[_____kg] [_____pounds]
[Gravel] [Slag] [Aggregate] surfacing	[_____kg] [_____pounds]
Approximate total weight	[_____kg] [_____pounds]

3.2 PREPARATION

Verify that work of other trades that penetrates the roof deck or requires men and equipment to traverse the roof deck is complete.

Examine deck surfaces for inadequate anchorage, foreign material, moisture, and unevenness which would prevent the execution and quality of application.

Proceed with the roofing application only after defects have been corrected.

Starting work designates acceptance of the surfaces by the Contractor.

3.2.1 Protection of Property

3.2.1.1 Protective Coverings

Install protective coverings at paving and building walls adjacent to hoists and kettles prior to starting the work. Lap protective coverings not less than six inch, secure against wind, and vent to prevent collection of moisture on covered surfaces. Keep protective coverings in place for the duration of the roofing work.

3.2.1.2 Bitumen Stops

Provide felt bitumen stops or other means to prevent bitumen drippage at roof edges, openings, and vertical projections before hot mopped application of the roofing membrane. Form felt bitumen stops with two 300 mm 12 inch wide strips of organic ply felt. Laminate with and set strips into a coating of asphalt roof cement with one-half of the width overhanging the edge of the roof or opening. Where nailers are provided, nail the strips with roofing nails spaced 300 mm 12 inch on center in addition to embedding in asphalt roof cement. Protect the free portion of each strip from damage throughout the roofing period. After the plies of felt are in place, fold free portion of the strips back over the roofing membrane and embed in a continuous coating of asphalt roof cement. Secure with roofing nails spaced 75 mm 3 inch on center.

3.2.2 Equipment

3.2.2.1 Mechanical Application Devices

Provide and maintain mechanical application devices with pneumatic tires that operate without damaging the insulation, roofing membrane, or structural components.

3.2.2.2 Flame-Heated Equipment

Do not place flame-heated equipment on roof. Provide and maintain a fire extinguisher adjacent to flame-heated equipment and on the roof.

[3.2.2.3 Open Flame Application Equipment

Use only open flame equipment recommended by the roofing materials manufacturer. Do not ignite open flame equipment when left unattended. Provide and maintain a fire extinguisher adjacent to open flame equipment on the roof.

]3.2.3 Priming of Surfaces

Prime all surfaces to be in contact with adhered membrane materials. Apply primer at the rate of 3 liters per 10 sq. meters 0.75 gallon per 100 sq. ft.or as recommended by roof membrane manufacturer's printed instructions to promote adhesion of membrane materials. Allow primer to dry prior to application of membrane materials to primed surface. Avoid flammable primer material conditions in torch applied membrane base flashing applications.

[3.2.3.1 Priming of Concrete and Masonry Surfaces

****

NOTE: Include this paragraph when roofing and base

flashing are applied directly to concrete or masonry surfaces.
****

After surface dryness requirements have been met, coat concrete and masonry surfaces which are to receive roofing and base flashing uniformly with primer. Allow primer to dry before application of roofing and flashing materials.

]3.2.3.2 Priming of Metal Surfaces

Prime flanges of metal components to be embedded into the roofing system prior to setting in bituminous materials or stripping into roofing system.

3.2.4 Covering of Wood Substrate

Cover wood substrate with a layer of unsaturated felt or rosin-sized building paper lapped 50 mm 2 inch at sides and 100 mm 4 inch at ends. Nail to hold in place prior to application of roofing system.

3.2.5 Heating of Asphalt

Break up solid asphalt on a surface free of dirt and debris. Heat asphalt in kettle designed to prevent contact of flame with surfaces in contact with the asphalt. Provide visible working thermometer and thermostatic controls set to the temperature limits. Keep controls in working order and calibrated. Use immersion thermometer, accurate within a tolerance of plus or minus one degree C 2 degrees F, to check temperatures of the asphalt frequently. When temperatures exceed maximum specified, remove asphalt from the site. Do not permit cutting back, adulterating, or fluxing of asphalt.

3.2.5.1 Temperature Limitations for Asphalt

Heat and apply asphalt at the temperatures specified below unless specified otherwise by manufacturer's printed application instructions. Use thermometer to check temperature during heating and application. Have kettle attended constantly during heating process to ensure specified temperatures are maintained. Do not heat asphalt above its finished blowing temperature (FBT). Do not heat asphalt between 260 and 274 degrees C 500 and 525 degrees F for longer than four consecutive hours. Do not heat asphalt to the flash point (FP). Apply asphalt and embed membrane sheets when temperature of asphalt is within plus or minus 14 degrees C 25 degrees F of the equiviscous temperature (EVT). Before heating and application of asphalt refer to the asphalt manufacturer's label or bill of lading for FP, FBT, and EVT of the asphalt used.

3.3 APPLICATION

****
NOTE: Include requirements for temporary roofing and flashing when construction will require considerable work on roof (that is, installing cooling towers, antennas, pipes, ducts, solar collectors) and temporary roofing is considered necessary to ensure that permanent roofing is not damaged during construction.
****

Apply roofing materials as specified unless approved otherwise by the Contracting Officer. Keep roofing materials dry before and during application. Except for aggregate surfacing, complete application of roofing in a continuous operation. Begin and apply only as much roofing in one day as can be completed that same day. Maintain specified temperature for asphalt. [Provide temporary roofing and flashing as specified herein prior to application of permanent roofing system.] Do not apply aggregate surfacing until the other roofing application procedures specified herein are completed.

3.3.1 Phased Membrane Construction

****
NOTE: Include bracketed option only when granule-surfaced modified bitumen cap sheet is specified as the built-up roof surfacing.
****

Phased application of membrane plies is prohibited. [Any delay in modified bitumen cap sheet installation will result in thorough cleaning of the applied membrane material surface and drying immediately prior to cap sheet installation. Priming of the applied membrane surface may be required at the discretion of the Contracting Officer prior to cap sheet installation.]

[3.3.2 Temporary Roofing and Flashing

Provide watertight temporary roofing and flashing where considerable work by other trades, such as installing [cooling towers,] [antennas,] [pipes,] [ducts,] [_____,] is to be performed on the roof or where construction scheduling or weather conditions require protection of building interior before permanent roofing system can be installed. Do not install temporary roofing over permanently installed insulation. Provide rigid pads for traffic over temporary roofing.

3.3.2.1 Removal

Completely remove temporary roofing and flashing before continuing with application of permanent roofing system.

][3.3.3 Base Sheet Application - General

****
NOTE: Include this paragraph when either base sheet or ventilating base sheet is specified in paragraph DESCRIPTION OF ROOF MEMBRANE SYSTEM.

Mechanically fastened base sheets are required when uninsulated roof membrane system is to be applied directly to nailable decks, excluding steel deck. Ventilating base sheet is required when roof membrane is applied directly to wet fill deck materials like lightweight insulating or cellular concrete and gypsum fill, and when applied over new poured concrete decks.
****

****
NOTE: Select the applicable application method.

Delete other options.

Delete requirements for adhered base sheets where the sheet is to be mechanically fastened through to nailable deck.

Apply base sheets at right angles to roof slope, except on insulated roofs where nailers (insulation stops) have been applied at right angles to slope and on decks sloped 1:12 25 mm per meter 1 inch per foot or more, apply felts parallel to roof slope. Include requirements for applying felts to barrel-type roofs only when applicable.

****

[[Fully adhere][Spot adhere]base sheets in accordance with membrane manufacturer's printed instructions. [Provide spot adhesion with hot asphalt applied in 300 mm 12 inch diameter spots installed in two staggered rows, centered 300 mm 12 inch in from edge of the base sheet.] Roll and broom in the base sheet to ensure full contract with the hot asphalt application.] [On nailable substrates, mechanically fasten base sheet in conformance with specified wind resistance requirements and membrane manufacturer's printed instructions, and to include increased fastening frequency in corner and perimeter areas. Drive fasteners flush with no dishing or cupping of fastener plate. Where applicable, base sheet may be mechanically fastened in conjunction with insulation to the substrate, in accordance with membrane manufacturers printed instructions.] Apply sheets in a continuous operation. Apply sheets with side laps at a minimum of 50 mm 2 inch unless greater side lap is recommended by the manufacturer's standard written application instructions. Provide end laps of not less than 150 mm 6 inch and staggered a minimum of 1 meter 36 inch. Apply sheets [at right angles to the roof slope so that the direction of water flow is over and not against the laps] [parallel to the roof slope] [so that plies of sheets extend from eave line on one side of the barrel-type roof and 450 mm 18 inch over the center line of the crown of the roof. Apply sheets on the other side in the same manner, resulting in twice the normal amount of roofing sheets and asphalt at the crown]. Extend base sheets approximately 50 mm 2 inch above the top of cant strips at vertical surfaces and to the top of cant strips elsewhere. Trim base sheet to a neat fit around vent pipes, roof drains, and other projections through the roof. Retrofit roof drains must conform to ANSI/SPRI RD-1. Application must be free of ridges, wrinkles, and buckles.

[3.3.3.1 Ventilating Base Sheets

****

NOTE: Include this paragraph in conjunction with applicable portions of the above paragraph when ventilating base sheets are specified in paragraph DESCRIPTION OF ROOF MEMBRANE SYSTEM.

Where rigid roof insulation is a component of the roof system, specify ventilating base sheet in the appropriate roof insulation section.

****

Apply ventilating base sheet material recommended by the roof membrane manufacturer. Extend sheets over roof cants, up vertical surfaces, and

terminate under cap flashing; at roof edges terminate sheets under outside edge of perimeter edge nailers or under gravel stop. [Top mop perforated ventilating base sheet with a full, continuous mopping of hot asphalt.]

]]3.3.4 Ply Felts

****

NOTE: Apply roofing felts at right angles to the roof slope, except that on insulated roofs where surface-applied wood nailers (insulation stops) have been applied running at right angles to roof slope and on decks sloped 1:6 50 mm per meter 2 inch per foot or more, apply the roofing felts parallel to roof slope. Delete the add-on requirement for applying felts to barrel-type roofs when not applicable.

****

Ensure proper alignment of felts prior to installation. [Apply ply felts shingle fashion perpendicular to slope of roof, including application on areas of tapered insulation that change slope direction.][Apply ply felts parallel to slope of roof [so that plies of felt extend from eave line on one side of barrel-type roof and 450 mm 18 inch over center line of the crown of roof. Apply felts on other side in same manner, resulting in twice normal amount of roofing felts and asphalt at crown].] Bucking or backwater laps are prohibited. Apply felts in a continuous operation. Provide starter sheets of felt to maintain the specified number of plies throughout the roofing. Apply felts with side laps in accordance with the material manufacturer's printed instructions for the number of plies to be installed and in uniform alignment. Lap ends not less than 150 mm 6 inch and stagger one meter 36 inch minimum. Place the full width of each ply in hot bitumen immediately behind the bitumen applicator. Lay plies free of wrinkles, creases, ridges, or fishmouths. Extend felts approximately 50 mm 2 inch above top of cant strips at vertical surfaces and to top of cant strips elsewhere. Trim felts to a neat fit around vent pipes, roof drains, and other projections. Avoid traffic on mopped surfaces when the bitumen is fluid and for a minimum of one hour after ply application.

3.3.4.1 Hot-Mopping of Ply Felts

Bond plies to each other and to the [base sheets] [substrate] with hot asphalt. Apply felts immediately following application of asphalt. Do not work ahead with asphalt. At the instant felts come into contact with asphalt, asphalt must be completely fluid, with asphalt temperatures within specified EVT range. Apply asphalt uniformly in a full, continuous mopping and firmly bonding film. Apply asphalt at the rate of approximately 13 kg per 10 sq. meters 25 pounds per 100 sq. feet plus or minus 25 percent. Require application rate on the high end of the application range when mopping directly to absorptive insulation substrates of perlite and woodfiber. As felts are rolled into the hot asphalt, immediately squeegee, roll or broom down to eliminate trapped air and to provide tight, smooth laminations without wrinkles, buckles, kinks, or fish mouths. Bitumen must be visible beyond all edges of each ply as it is being installed. Install individual ply and the completed roof membrane system free of air pockets, felt delaminations, ridges, creases, fishmouths, dry laps, or blisters. Do not lay felts dry or turn back laps for mopping between plies.

[3.3.4.2 Backnailing of Ply Felts

****

NOTE: Backnailing is required generally for slopes of 25 mm 1 inch or greater for Type III asphalt, 15 mm 1/2 inch for Type I asphalt at a maximum backnail spacing of 305 mm 12 inches. However, due to technical improvements in today's materials and methodology, backnailing is becoming obsolete.

On low slope roofs 15 mm 1/2 inch to 1 inch per foot,) depending on the products used, apply felts shingle fashion, perpendicular to slope, starting at the lowest point.

On slopes greater than 25 mm 1 inch, require backnailing and install nailers of the same thickness as the roof insulation. Run felts parallel to slope and nail through the back edge of the felts into the nailers

When roof slope exceeds 1:6 50 mm per meter 2 inch per foot include the applicable paragraphs on backnailing. For insulated roofs, delete the second bracketed option. For uninsulated roofs on nailable decks, delete the first bracketed option and include only the second.

****

Unless otherwise recommended by the roof membrane manufacturer and approved by the Contracting Officer, [provide minimum 90 mm 3-1/2 inch wide nailing strips matching insulation thickness and applied perpendicular to roof slope for backnailing of roof membrane. Space nailing strips as recommended by the membrane manufacturer, but not exceeding 5 meters 16 feeton center unless approved otherwise by the Contracting Officer. Coordinate the nailer installation with insulation requirements. As the felt plies are installed, nail each ply 25 mm 1 inch from the leading edge at each nailer line.] [fasten each felt ply 25 mm 1 inch from the leading edge and spaced at maximum 5 m 15 feet on center along the leading edge.] Provide fasteners with a 25 mm 1 inch diameter metal cap or fasten through 25 mm 1 inch diameter caps. Set fasteners firm and flush without puncturing felt ply. Conceal fasteners with succeeding plies of felt.

]3.3.4.3 Valleys and Ridges

Valleys: Apply roofing at valleys and waterways in the following manner:

Continue base sheets across valleys and terminate 450 millimeter 18 inchfrom the valley.

Continue felt plies across valleys and terminate 300 millimeter 12 inch from the valley. Terminate exposed laps on a line 300 millimeter 12 inch from, and parallel to, the gutter valley. Provide two plies of felt, 225 and 300 millimeter 9 and 12 inch wide, successively mop in over each felt line of the termination.

If the application can be completed without wrinkles, buckles, or fishmouths and if side laps do not face the direction of drainage,

roofing felts and base sheets may be laid continuously across or parallel to shallow valleys such as those formed by reverse-slope roofs. For this application, reinforce valleys with one ply of felt, 900 millimeter 36 inch wide, center on the valley gutter and lay in a solid mopping of asphalt over the top ply of roofing.

3.3.5 Membrane Flashing

Provide two plies of modified bitumen membrane strip flashing and sheet flashing in the angles formed where the roof deck abuts walls, curbs, ventilators, pipes, and other vertical surfaces, and where necessary to make the work watertight. Top ply of flashing must be granule-surfaced modified bitumen membrane. Install flashing after plies of roof membrane felt have been applied but before aggregate surfacing is applied. Cut at a 45 degree angle across terminating end lap area of cap membrane prior to applying adjacent overlapping cap membrane. Press flashing into place to ensure full adhesion and avoid bridging. Ensure full lap seal in all lap areas. Mechanically fasten top edge of base flashing 150 mm 6 inch on center through minimum 25 mm 1 inch diameter tin caps with fasteners of sufficient length to embed minimum 25 mm 1 inch into attachment substrate.[Apply matching granules in any areas of asphalt bleed out while the asphalt is still hot.] Apply membrane liner over top of exposed nailers and blocking and to overlap top edge of base flashing installation at curbs, parapet walls, expansion joints and as otherwise indicated to serve as waterproof lining under sheet metal flashing components.

3.3.5.1 Strip Flashing

Set primed flanges of sheet metal flashings to be incorporated into roofing system in a uniform coating of asphalt roof cement not less than 1/16 inch thick applied over the ply felts. Strip-in with one layer of smooth surface modified bitumen membrane and cap with granule-surfaced modified bitumen membrane. Set strip flashing in hot asphalt or cement to the tops of the flanges, roofing membrane, and to each other. Use coatings of asphalt roof cement not less than 1/16 inch thick for ply felt. Use hot asphalt or modified bitumen cement for modified bitumen sheets. Extend first stripping ply not less than 100 mm 4 inch beyond outer edge of flange onto roof membrane. Extend each additional ply 100 mm 4 inch beyond the edge of the previous ply.

[3.3.5.2 Membrane Flashing at Roof Drain

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NOTE: Include these requirements where roof drains are provided. Roof drains are specified in Section 22 00 00 PLUMBING, GENERAL PURPOSE. Flashings for roof drains are specified in Section 07 60 00 FLASHING AND SHEET METAL.

****

Extend roofing plies to edge of drain bowl opening at roof drain deck flange. Neatly fit and press primed roof drain flashing into heavy coat of asphalt roof cement applied to top of roofing plies. Strip in and completely cover flashing with two layers of modified bitumen sheet, extending the first sheet 150 mm 6 inch on the roofing beyond the edge of flashing. Extend the cap sheet 150 mm 6 inch beyond the previous flashing ply. Bond the two layers to the metal flashing and to each other with hot asphalt. Securely clamp membrane, metal flashing, and strip flashing in the flashing clamping ring. Secure clamps so that strip flashing and

metal flashing are free from wrinkles and folds. Trim membrane, flashing, and stripping flush with inside of clamping ring.

][3.3.5.3 Pre-fabricated Curbs

Anchor prefabricated curbs securely to nailer or other base substrate as indicated and flash with modified bitumen flashing membrane.

]3.3.5.4 Set-On Accessories

Where pipe or conduit blocking, supports and similar roof accessories are set on the membrane, adhere walkpad material to bottom of accessories prior to setting on roofing membrane. Install set-on accessories to permit normal movement due to expansion, contraction, vibration, and similar occurrences without damaging roofing membrane. Do not mechanically secure set-on accessories through roofing membrane into roof deck substrate.

3.3.5.5 Lightning Protection

Flash or attach lightning protection system components to the roof membrane in a manner acceptable to the roof membrane manufacturer.

[3.3.6 Roof Walkpads

Install walkpads at roof access points and where otherwise indicated for traffic areas and for access to mechanical equipment, in accordance with the modified bitumen sheet roofing manufacturer's printed instructions. Provide minimum 150 mm 6 inch separation between adjacent walkpads to accommodate drainage. Provide walkpad [or an additional layer of cap sheet] under precast concrete paver blocks to protect the roofing.

][3.3.7 Elevated Metal [Walkways] [and] [Platforms]

Provide protection mat of walkpad material, or other material approved by the Contracting Officer, at all surface bearing support locations.

]3.3.8 Paver Blocks

Install paver blocks where indicated and as necessary to support surface bearing items traversing the roof area. Set paver block on a layer of walkpad [or modified bitumen cap sheet] applying over the completed roof membrane.

****
NOTE: Include only the applicable surfacing, delete the other option.
****

[3.3.9 Aggregate Surfacing

After completion of roof membrane ply and flashing installation, and correction of tears, gouges or other deficiencies in the installed work, apply aggregate surfacing. Uniformly flood coat the surface with hot asphalt at a rate of approximate 2.9 kg 60 pounds per square. While asphalt is still hot, apply gravel aggregate surfacing material at a rate of 19.5 kg 400 pounds per square. Provide for full and uniform coverage of the roof surface. Approximately 50 percent of the aggregate must be solidly adhered in the asphalt.

][3.3.10 Granule-Surfaced Modified Bitumen Cap Sheet

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NOTE: Include the option of hot asphalt or torch application of cap sheet where permissible. Torch applied cap sheet can be applied over hot mopped membrane plies.

Where finished appearance of the roof is of consequence, include the bracketed requirement for granule application in areas of bitumen bleed out.

****

Inspect underlying applied membrane and repair free of damage, holes, puncture, gouges, abrasions, and any other defects, and free of moisture, loose materials, debris, sediments, dust, and any other conditions required by the membrane manufacturer prior to cap sheet installation. Provide cleaning and artificial drying with heated blowers or torches to ensure clean, dry surface prior to cap sheet application. When delays in cap sheet installation may have occurred, do not apply cap sheet if underlying materials have been exposed to rain or frozen precipitation within the previous 24 hours. Unroll cap sheet membrane and allow to relax a minimum of 1 hour prior to installation and as otherwise recommended by the membrane manufacturer. Apply cap sheet in same direction as the underlying felt plies. Align cap membrane and apply with minimum 75 mm 3 inch side laps and minimum 150 mm 6 inch end laps and as otherwise required by membrane manufacturer. Set cap sheet in hot asphalt. Cap sheet may be torch applied with approval of the Contracting Officer and written approval of the felt membrane manufacturer, and as recommended by the modified bitumen membrane manufacturer. Cut at a 45 degree angle across selvage edge of cap membrane to be overlapped in end lap areas prior to applying overlapping cap membrane.[Apply matching granules in any areas of bitumen bleed out while the bitumen is still hot]. Minimize traffic on newly installed cap sheet membrane.

[3.3.10.1 Backnailing of Cap Sheet Membrane

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NOTE: Include this paragraph for roof slopes greater than or equal to 1:6 50 mm per meter 2 inch per foot. Coordinate with insulation Section 07 22 00 ROOF AND DECK INSULATION and nailer requirements Section 06 10 00 ROUGH CARPENTRY to allow for backnailing of the membrane.

****

Unless otherwise recommended by the roof membrane manufacturer and approved by the Contracting Officer, install the modified bitumen cap sheet to provide for end laps at nailer locations. Nail the modified bitumen cap sheet at the end lap area across the width of the sheet. Nail within 25 mm 1 inch of each edge of the sheet and at 200 mm to 215 mm 8 to 8-1/2 inchon center across the width of the sheet in a staggered fashion. Provide nails with a 25 mm 1 inch diameter metal cap or nail through 25 mm 1 inch diameter caps. Cover nails by overlapping adjacent upslope sheet at the end lap area.

]]3.3.11 Correction of Deficiencies

Where any form of deficiency is found, take additional measures to determine the extent of the deficiency and perform corrective actions as directed by the Contracting Officer.[Where interply moppings are too light, apply additional two plies of felt in full moppings of asphalt. Apply with 100 mm4 inch side and end laps. Where free water, skips, excessive voids, dry laps, desponding or any form of delamination are discovered between the plies, remove and rebuild affected area. Correction of inadequate number of plies, improper lap widths, or non-uniform or excessive asphalt mopping must be as directed by the Contracting Officer.] Where insulation is found to be wet, remove insulation and provide new built-up roofing and insulation.

3.3.12 Clean Up

Remove debris, scraps, containers and other rubbish and trash resulting from installation of the roofing system from job site each day.

3.4 PROTECTION OF APPLIED ROOFING

3.4.1 Protection Against Moisture Absorption

When precipitation is imminent and at the end of each day's work, protect applied roofing as follows:

[3.4.2 Water Cutoffs

****
NOTE: Include this paragraph when roof insulation is a substrate for the modified bitumen sheet roofing.
****

Straighten insulation line using loose-laid cut insulation sheets and seal the terminated edge of modified bitumen roofing system in an effective manner.[Seal off flutes in metal decking along the cutoff edge.] Remove the water cutoffs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

]3.4.3 Temporary Flashing for Permanent Roofing

Provide temporary flashing at drains, curbs, walls and other penetrations and terminations of roofing sheets until permanent flashings can be applied. Remove temporary flashing before applying permanent flashing.

3.4.4 Temporary Walkways, Runways, and Platforms

Do not permit storing, walking, wheeling, and trucking directly on applied roofing materials. Provide temporary walkways, runways, and platforms of smooth clean boards, mats or planks as necessary to avoid damage to applied roofing materials, and to distribute weight to conform to live load limits of roof construction. Use rubber-tired equipment for roofing work.

[3.4.5 Glaze Coat

Use light glaze coating of bitumen to waterproof roof areas requiring extended time to complete. Glaze coating must be at the discretion of the

Contracting Officer. Apply bitumen glaze coat on exposed felts at a rate of0.25 kg to 0.50 kg per square meter 5 to 10 pounds per square. Lower application rates, in accordance with membrane manufacturer's recommendations, may be required when modified bitumen cap sheet surfacing is specified. Provide valleys and low areas that may pond water with glaze coating.

]3.5 FIELD QUALITY CONTROL

Perform field tests in the presence of the Contracting Officer. Notify the Contracting Officer one day before performing tests.

3.5.1 Test for Surface Dryness

Before application of insulation or membrane materials and starting work on the area to be roofed, perform test for surface dryness in accordance with the following:

a. Foaming: When poured on the surface to which materials are to be applied, one pint of asphalt when heated in the range of 176 to 204 degrees C 350 to 400 degrees F, must not foam upon contact.

b. Strippability: After asphalt used in the foaming test application has cooled to ambient temperatures, test coating for adherence. Should a portion of the sample be readily stripped clean from the surface, do not consider the surface to be dry and do not start application. Should rain occur during application, stop work and do not resume until surface has been tested by the method above and found dry.

c. Prior to installing any roof system on a concrete deck, conduct a test per ASTM D4263. The deck is acceptable for roof system application when there is no visible moisture on underside of plastic sheet after 24 hours.

3.5.2 Construction Monitoring

During progress of the roof work, perform visual inspections to ensure compliance with specified parameters. Additionally, verify the following:

a. Equipment is in working order. Metering devices are accurate.

b. Materials are not installed in adverse weather conditions.

c. Substrates are in acceptable condition, in compliance with specification, prior to application of subsequent materials.

Nailers and blocking are provided where and as needed.

Insulation substrate is smooth, properly secured to its substrate, and without excessive gaps prior to membrane application.

The proper number, type, and spacing of fasteners are installed.

Materials comply with the specified requirements.

All materials are properly stored, handled and protected from moisture or other damages.

Asphalt is heated and applied within the specified temperature

parameters.

Hot asphalt application is provided uniformly for voidless coverage and as necessary to ensure full adhesion of materials. Materials are set in place while asphalt is within the specified temperature range.

The proper number and types of plies are installed, with the specified overlaps.

Applied membrane surface is inspected, cleaned, dry, and repaired as necessary prior to cap sheet installation.

Membrane is without ridges, wrinkles, kinks, fishmouths, or other voids or delaminations.

Installer adheres to specified and detailed application parameters.

Associated flashings and sheet metal are installed in a timely manner in accord with the specified requirements.

Temporary protection measures are in place at the end of each work shift.

[3.5.2.1 Manufacturer's Inspection

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NOTE: Include this paragraph when manufacturer's inspection of work is required. Select desired frequency of manufacturer inspection and coordinate with text of optional 2nd and 3rd bracketed sentences.
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Manufacturer's technical representative must visit the site a minimum of three [_____] times [once per week] during the installation for purposes of reviewing materials installation practices and adequacy of work in place.[Inspect during the first 20 squares of membrane installation, at mid-point of the installation, and at substantial completion prior to surfacing application, at a minimum. Additional inspections must not exceed one for each 100 squares of total roof area with the exception that follow-up inspections of previously noted deficiencies or application errors must be performed as requested by the Contracting Officer.] After each inspection, submit a report, signed by the manufacturer's technical representative to the Contracting Officer within 3 working days. The report must note overall quality of work, deficiencies and any other concerns, and recommended corrective action.

]3.5.3 Samples of Built-Up Roofing

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NOTE: This requirement is included for optional enforcement at the discretion of the Contracting Officer. It is not the intent to require cut samples on all roof projects.
****

After application of specified roofing felts and prior to applying surfacing, take field samples of built-up roofing as directed by the

Contracting Officer. Take and test samples in accordance with ASTM D3617 and at locations selected by the Contracting Officer immediately prior to cutting. Cut 100 mm by 1000 mm 4 inch by 40 inch samples across felt laps in a manner to expose the specified number of plies. The 100 mm 4 inch edge must coincide with an edge lap of felt and not be positioned over an end lap. Use 100 mm by 1000 mm 4 inch by 40 inch samples for visual inspection. The Contracting Officer will inspect the samples for the specified number of plies, bond between plies, skips in interply moppings, uniform asphalt mopping, presence of excessive voids or large voids in the ply construction, presence of harmful foreign materials, visible presence of moisture in the sandwich and wet insulation. Use 300 mm by 300 mm 12 inch by 12 inch cut samples to calculate bitumen quantities in accordance with ASTM D3617 and directed by the Contracting Officer. Do not proceed with surfacing until all deficiencies disclosed as a result of cut tests have been corrected and approved by the Contracting Officer. Where cuts are not retained by the Contracting Officer or disposed, set cut strip back in cut area and patch as specified.

3.5.3.1 Number of Cut Tests

Take cut samples as directed by the Contracting Officer for quality assurance validation or as necessary to determine the extent of deficiencies discovered in the construction. Except where cut samples are taken to investigate deficiencies, provide no more than two cut samples per 1000 square meters 100 squares or one cut sample from each day's work.

3.5.3.2 Sample Cutting Device

Provide a rectangular, 100 mm by 1000 mm 4 inch by 40 inch template and 300 mm by 300 mm 12 inch by 12 inch template, of a type that will permit accurate cutting of samples with standard roofing knives. Keep cutting edge of knife clean by washing in solvent after each cut.

3.5.3.3 Patching Cut-Out Area

Immediately after inspection, replace cut-out sample. When sample is needed for laboratory analysis or other circumstance makes it unavailable, substitute a new section of equivalent size and structure. For non-nailable decks, replace sample in hot asphalt. For nailable decks, insert one ply of ply felt into opening from which sample was taken and sprinkle nail to hold in place; coat felt heavily with asphalt roof cement and press cutout sample firmly into asphalt roof cement. Repair area of cut with new patch of the same number of plies as the primary roof membrane. Extend the first ply minimum 150 mm 6 inch all around the cut area. Extend each additional ply minimum 100 mm 4 inch beyond the previous ply.

[3.5.4 Roof Drain Test

****
NOTE: Include this paragraph when roof drains are required. Consult with structural engineer to verify loading capability of roof structural system.
****

After roofing system is complete except for surfacing, perform the following test of roof drains and adjacent roofing for watertightness. Plug roof drains and fill with water to edge of drain sump for 8 hours. Do not plug secondary overflow drains at same time as adjacent primary

drain. To ensure some drainage from roof, do not test all drains at same time. Measure water at beginning and end of the test period. When precipitation occurs during test period, repeat test. When water level falls, remove water, thoroughly dry, and inspect the installation. Repair or replace roofing at drain to provide for a properly installed watertight flashing seal. Repeat test until there is no water leakage.

][3.6 INFRARED INSPECTION

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NOTE: This optional requirement should be included only under special circumstances and on roof systems conducive to effective infrared scanning, or as otherwise instructed. This section may be necessary at project locations where infrared inspections cannot be performed during construction due to climate or other adverse conditions.

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[Eight][_____] months after completion of the roofing system, the Contractor must inspect the roof surface using infrared (IR) scanning as specified in ASTM C1153. Where the IR inspection indicates moisture intrusion, replace wet insulation and damaged or deficient materials or construction in a manner to provide watertight construction and maintain the specified roof system warranties.[Coordinate infrared inspections with building envelope commissioning activities.]

]3.7 INFORMATION CARD

For each roof, furnish a typewritten information card for facility records and a photoengraved 1 mm 0.032 inch thick aluminum card for exterior display. Card must be 215 mm by 275 mm 8-1/2 by 11 inch minimum, identifying facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, membrane, number of plies, method of application, manufacturer, insulation and cover board system and thickness; presence of tapered insulation for primary drainage, presence of vapor retarder; date of completion; installing contractor identification and contact information; membrane manufacturer warranty expiration, warranty reference number, and contact information. Install card at roof top or access location as directed by the Contracting Officer and provide a paper copy to the Contracting Officer.

-- End of Section --