
USACE / NAVFAC / AFCEA UFGS-07550 (March 2004)

Preparing Activity: NAVFAC Superseding
UFGS-07550N (September 1999) and
UFGS-07551A (January 2002)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

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DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07550

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03/04

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SECTION 07550

MODIFIED BITUMINOUS MEMBRANE ROOFING 03/04

NOTE: This guide specification covers the requirements for modified bitumen sheet roofing. Hot mopped asphalt, torch applied, and cold-applied adhesive applications are included. Both SBS and APP modified bitumen membranes are included.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

NOTE: APP systems are allowed for Army projects only. This guide specification does not include the structural roof deck, insulation, or sheet metal fascias, gravel stops, and flashings.

Acids, hydrocarbons, oil, and cooking greases attack modified sheet roofing. When these contaminants may be a problem on a roof, contact modified bitumen sheet manufacturers for specific recommendations.

This section shall be coordinated with other roof system components specifications such as rough carpentry, insulation and sheet metal flashing. This section shall also be coordinated with the criteria contained in Unified Facilities Criteria (UFC) 3-110-06 DESIGN: ROOFING as it relates to the specific project and Service Exceptions indicated

therein.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

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 (2002) Minimum Design Loads for Buildings and Other Structures

ASTM INTERNATIONAL (ASTM)

ASTM C 1153	(1997; R 2003e1) Location of Wet Insulation in Roofing Systems Using Infrared Imaging
ASTM C 208	(1995; R 2001) Cellulosic Fiber Insulating Board
ASTM C 728	(1997e1) Perlite Thermal Insulation Board
ASTM D 1863	(1993; R 2003) Mineral Aggregate Used on Built-Up Roofs
ASTM D 2170	(2001a) Kinematic Viscosity of Asphalts (Bitumens)
ASTM D 2824	(2002) Aluminum-Pigmented Asphalt Roof Coatings, Non-Fibered, Asbestos Fibered, and Fibered without Asbestos
ASTM D 312	(2000) Asphalt Used in Roofing
ASTM D 41	(1994; R 2000e1) Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
ASTM D 4402	(2002) Viscosity Determination of Asphalt at Elevated Temperatures Using a Rotational Viscometer
ASTM D 4586	(2000) Asphalt Roof Cement, Asbestos Free
ASTM D 4601	(1998) Asphalt-Coated Glass Fiber Base Sheet Used in Roofing

ASTM D 4637	(2003) EPDM Sheet Used in Single-Ply Roof Membrane
ASTM D 4897	(2001) Asphalt-Coated Glass-Fiber Venting Base Sheet Used in Roofing
ASTM D 6162	(2000a) Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements
ASTM D 6163	(2000e1) Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Glass Fiber Reinforcements
ASTM D 6164	(2000) Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using Polyester Reinforcements
ASTM D 6222	(2002) Atactic Polypropylene (ARP) Modified Bituminous Sheet Materials Using Polyester Reinforcements
ASTM D 6223	(2002) Atactic Polypropylene (ARP) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements
ASTM D 6298	(2000) Fiberglass Reinforced Styrene-Butadiene-Styrene (SBS) Modified Bituminous Sheet with Factory Applied Metal Surface
ASTM D 6848	(2002) Aluminum Pigmented Emulsified Asphalt Used as a Protective Coating for Roofing
ASTM E 108	(2000) Fire Tests of Roof Coverings
FM GLOBAL (FM)	
FM AS 4470	(1986; R 1992) Class I Roof Covers
FM P7825	(2003) Approval Guide
FM P7825c	(2003) Approval Guide Building Materials
UNDERWRITERS LABORATORIES (UL)	
UL 790	(2004) Test Methods for Fire Tests of Roof Coverings
UL RMSD	(2004) Roofing Materials and Systems Directory

1.2 DESCRIPTION OF ROOF MEMBRANE SYSTEM[S]

NOTE: Coordinate with Part 2 materials specification.

Where one membrane system is required for all roof areas, use the first paragraph. Where different systems are required, use the second paragraph successively and replace the open brackets with a description of the substrate(s) or area of the building or project where each system is to be applied.

Specify the three-ply option including base sheet, interply sheet and cap sheet when mechanical fastening of bottom ply is required either directly to nailable deck or over insulation substrate and into nailable deck, and when perforated base sheet is used. Otherwise, specify two-ply option including modified bitumen base sheet and cap sheet.

Two-ply option may also be considered when the mechanical fastening of the modified bitumen base ply is concealed in the finished base ply installation (i.e., no exposed fasteners in the base ply prior to application of cap sheet such as occurs in base sheets fastened only in the side lap area and where the overlapping adjacent base sheet is torch sealed over the fasteners in the lap area).

One ply modified bitumen roof membrane shall not be specified without prior Government approval and shall only be considered for application on open air sheds or light storage structures and ancillary buildings of little importance. One ply membrane includes application of a single ply directly to deck or insulation substrate or over mechanically fastened or perforated base sheets.

Specify SBS for all hot asphalt membrane applications. Torch applied and cold adhesive applications may include either or both SBS and APP, selected based on the specific application and service conditions intended. APP systems are allowed on Army projects only.

Felt base sheet may be specified in a low to moderate service three-ply application. Specify venting base sheet for application directly to new concrete deck and over nailable lightweight fill substrate materials.

Minimum [two-ply][three-ply] SBS [or] [APP] modified bitumen roof membrane consisting of [modified bitumen base sheet][fiberglass felt [venting]base sheet] [,interply sheet] and cap sheet. Modified bitumen roof membrane shall be [set in hot asphalt][torch applied][set in cold-applied adhesive].

*** OR ***

[_____]: Minimum [two-ply][three-ply] SBS [or] [APP] modified bitumen

roof membrane consisting of [modified bitumen base sheet][fiberglass felt
[venting] base sheet] [,interply sheet] and cap sheet. Modified bitumen
roof membrane shall be [set in hot asphalt][torch applied][set in
cold-applied adhesive].

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary
for adequate quality control. The importance of an
item in the project should be one of the primary
factors in determining if a submittal for the item
should be required.

A "G" following a submittal item indicates that the
submittal requires Government approval. Some
submittals are already marked with a "G". Only
delete an existing "G" if the submittal item is not
complex and can be reviewed through the Contractor's
Quality Control system. Only add a "G" if the
submittal is sufficiently important or complex in
context of the project.

For submittals requiring Government approval on Army
projects, a code of up to three characters within
the submittal tags may be used following the "G"
designation 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
projects.

Submittal items not designated with a "G" are
considered as being for information only for Army
projects and for Contractor Quality Control approval
for Navy projects.

Government approval is required for submittals with a "G" designation;
submittals not having a "G" designation are [for Contractor Quality Control
approval.][for information only. When used, a designation following the
"G" designation identifies the office that will review the submittal for
the Government.] The following shall be submitted in accordance with
Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Roof plan drawing depicting wind loads and boundaries of
enhanced perimeter and corner attachments of roof system
components, as applicable; G, [_____]

SD-03 Product Data

NOTE: Edit the product data submission requirements

as necessary for the system specified. Include bracketed requirements as applicable to the system being specified (e.g., torch applied systems may not require asphalt in the installation).

- Modified Bitumen Sheets; G, [_____]
- [Asphalt]
- [Cold-Applied Membrane Adhesive; G, [_____]]
- [Fiberglass Felt; G, [_____]]
- Primer; G, [_____]
- Modified Bitumen Roof Cement; G, [_____]
- [Pre-Manufactured Accessories]
- Fasteners And Plates; G, [_____]
- Vapor Pressure Relief Vents
- Sample Warranty certificate; G, [_____]

Submit all data required by Section 07220 ROOF AND DECK INSULATION, together with requirements of this section. Data shall include written acceptance by the roof membrane manufacturer of the products and accessories provided. Products shall be as listed in the applicable wind uplift and fire rating classification listings, unless approved otherwise by the Contracting Officer.

SD-05 Design Data

NOTE: Coordinate with requirements of "Wind Uplift" paragraph. Include bracketed requirement where non-rated systems may be permissible.

- Wind uplift calculations; G
- [Engineering calculations validating the wind resistance of non-rated roof system.]

SD-07 Certificates

Show evidence that products used within this specification are manufactured in the United States.

Qualification of Manufacturer

Certify that the manufacturer of the modified bitumen membrane meets requirements specified under paragraph entitled "Qualification of Manufacturer."

Qualification of Applicator

Certify that the applicator meets requirements specified under paragraph entitled "Qualification of Applicator."

NOTE: Include bracketed requirement when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

[bill of lading

Submit bill of lading when labels of asphalt containers do not bear the flash point (FP), finished blowing temperature (FBT), and equiviscous temperature (EVT).]

Wind Uplift Resistance classification, as applicable; G

Fire Resistance classification; G

Submit the roof system assembly [wind uplift and] fire rating classification listings.

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 (e.g., torch applied systems may not require asphalt in the installation).

Modified Bitumen Membrane Application; G

Flashing; G

[Temperature Limitations for Asphalt]

[Torches]

[Cold Adhesive Applied Modified Bitumen Membrane; 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.]

Primer

roof cement

Fasteners

Ventilating Base Sheets

[Coating Application; G]

cold weather 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

INSTRUCTIONS TO GOVERNMENT PERSONNEL

Include copies of Material Safety Data Sheets for maintenance/repair materials.

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Manufacturer

**NOTE: Specify 5 years manufacturer experience
unless directed otherwise by the Government**

Modified bitumen sheet roofing system manufacturer shall have a minimum of [5] [_____] years experience in manufacturing modified bitumen roofing products.

1.4.2 Qualification of Applicator

**NOTE: Specify 3 years as an approved contractor
unless directed otherwise by the Government**

Roofing system applicator shall be approved, authorized, or licensed in writing by the modified bitumen sheet roofing system manufacturer and shall have a minimum of [three] [_____] years experience as an approved, authorized, or licensed applicator with that manufacturer and be approved at a level capable of providing the specified warranty. The applicator shall supply the names, locations and client contact information of 5 projects of similar size and scope that the applicator has constructed using the manufacturer's roofing products submitted for this project within the previous three years.

1.4.3 Fire Resistance

Complete roof covering assembly shall:

**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 [or B] rated in accordance with ASTM E 108 , 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 P7825.

FM or UL approved components of the roof covering assembly shall bear the appropriate FM or UL label.

1.4.4 Wind Uplift Resistance

NOTE: Determine the required wind uplift resistance based on ASCE 7 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 2.2 kPa (45 psf). When a rated system is specified, ensure the specified roof system is capable of meeting the wind uplift resistance specified. Where non-rated systems may be permissible, include the bracketed option.

Complete roof covering assembly, including insulation, shall be rated Class 1-[60] [90] [_____] in accordance with FM P7825 capable of withstanding an uplift pressure of [2.85] [4.30] [_____] kPa per square meter ([60] [90] [_____] psf). Non-rated systems shall not be installed[, except as approved by the Contracting Officer. Provide wind load calculations and submit engineering calculations and substantiating data to validate wind resistance of any non-rated roof system. Wind uplift calculations shall be based on a design wind speed of [_____] km/h ([_____] mph) in accordance with ASCE 7 or 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.

Preroofing conference scheduling shall be coordinated with the Contracting Officer. The conference shall 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 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

**NOTE: Include bracketed requirement when hot-mopped
membranes are used or base sheets are hot-mopped to
non-nailable substrates.**

Deliver materials in manufacturers' original unopened containers and rolls with labels intact and legible. Mark and remove wet or damaged materials from the site. Where materials are covered by a referenced specification, the container shall bear the specification number, type, and class, as applicable. [Labels or bill of lading for roofing asphalt shall indicate asphalt type, FP, FBT, and EVT, that is, the temperature at which the viscosity is either 125 centistokes when tested in accordance with ASTM D 2170 or 75 centipoise when tested in accordance with ASTM D 4402.] Deliver materials in sufficient quantity to allow work to proceed without interruption.

1.5.2 Storage

Protect materials against moisture absorption and contamination or other damage. Avoid crushing or crinkling of roll materials. Store roll materials on end on clean raised platforms or pallets one level high in dry locations with adequate ventilation, such as an enclosed building or closed trailer. Do not store roll materials in buildings under construction until concrete, mortar, and plaster work is finished and dry. Maintain roll materials at temperatures above 10 degrees C (50 degrees F) for 24 hours immediately before application. 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. Do not store more materials on roof than can be installed the same day and remove unused materials at end of each days work. Distribute materials temporarily stored on roof to stay within live load limits of the roof construction. 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. Damaged materials shall not be installed in the work. Select and operate material handling equipment so as not to damage materials or applied roofing.

1.6 ENVIRONMENTAL REQUIREMENTS

Do not install roofing system when air temperature is below 4 degrees C (40 degrees F), during any form of precipitation, including fog, or when there is ice, frost, moisture, or any other visible dampness on the roof deck. Follow manufacturer's printed instructions for installation during cold weather conditions.

[1.7 TORCH SAFETY

**NOTE: This requirement shall be retained when
membrane or flashing is torch applied.**

Take all precautions necessary to prevent ignition of combustible materials during torch application of roofing. Flammable liquids shall not be stored on the roof. Provide two fully charged minimum 6.5 kg (15 pound) CO2 fire extinguishers in separate, easily accessible locations on the roof and within 9 meters (30 feet) of torch work area at all times. Seal off voids or openings in the substrate with non-combustible materials prior to installing torch-applied materials in the area. When working around intakes and openings, temporarily disconnect and block to prevent flame of torch from being drawn into the opening. Provide non-combustible shielding or flame guard protection where gaps or voids occur in the construction in area of torch work.

1.7.1 Fire Watch

Provide a fire watch for a minimum of one hour after completion of all torch work at the end of each work shift. Maintain the fire watch for additional time required to ensure no potential ignition conditions exist. Utilize heat sensing meters to scan for hot spots in the work. Do not leave the rooftop unattended during breaks in work during a work shift. Walk and scan all areas of application checking for hot spots, fumes, or smoldering, especially at wall and curb areas, prior to departure at the end of each work shift. Ensure any and all suspect conditions are eliminated prior to leaving the site each work shift.

]1.8 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. [Application of roofing shall immediately follow application of insulation as a continuous operation. Roofing operations shall be coordinated with insulation work so that all roof insulation applied each day is covered with roof membrane installation the same day.]

1.9 WARRANTY

Provide roof system material and workmanship warranties meeting specified requirements. Revision or amendment to standard membrane manufacturer warranty shall be provided as required to comply with the specified requirements.

1.9.1 Roof Membrane Manufacturer Warranty

NOTE: 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 intrusion and any time a one-ply modified bitumen membrane system is specified. Environmentally controlled interiors with one-ply membrane shall require minimum 10 year warranty.

Furnish the roof membrane manufacturer's [5] [10] [20]-year no dollar limit roof system materials and installation workmanship warranty, including flashing, insulation, and accessories necessary for a watertight roof system construction. The warranty shall run directly to the Government and commence at time of Government's acceptance of the roof work. The warranty shall state that:

- 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 shall be the responsibility of the roof membrane manufacturer. All costs associated with the repair or replacement work shall be the responsibility of the roof membrane manufacturer.
- b. When the manufacturer or his approved applicator fail to perform the repairs within 72 hours of notification, emergency temporary repairs performed by others shall not void the warranty.

1.9.2 Roofing System Installer Warranty

The roof system installer shall warrant for a period of not less than 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. The warranty shall run directly to the Government. Correction of defective workmanship and replacement of damaged or affected materials shall be the responsibility of the roof system installer. All costs associated with the repair or replacement work shall be the responsibility of the installer.

1.9.3 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty

period shall be approved, as required, 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.

1.10 CONFORMANCE AND COMPATIBILITY

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

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 MODIFIED BITUMEN SHEETS AND FIBERGLASS FELT MATERIALS

Furnish a combination of specified materials that comprise the modified bitumen manufacturer's standard system of the number and type of plies specified. Materials provided shall be suitable for the service and climatic conditions of the installation. Modified bitumen sheets shall be watertight and visually free of pinholes, particles of foreign matter, undispersed raw material, factory splices, or other conditions that might affect serviceability. Polymer modifier shall be uniformly dispersed throughout the sheet. Edges of sheet shall be straight and flat.

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.

Modified bitumen base sheet shall be specified for two-ply membrane systems and may be incorporated in three-ply membrane systems.

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 D 4897, Type II, [without] [with] perforations and as approved by the modified bitumen roof membrane manufacturer.]
- [b. Fiberglass Felt Base Sheet: ASTM D 4601, Type II, [without] [with] perforations and as approved by the modified bitumen roof membrane manufacturer.]

NOTE: When specifying a two-ply membrane system or application over a fiberglass felt base sheet, delete any reference to Interply sheet. Use modified bitumen base sheet and cap sheet.

Specify polyester-reinforced membrane for high traffic roofs and where enhanced puncture resistance and overall durability are required. Where polyester reinforced sheet is required, delete any reference to ASTM D 6163.

Do not specify fiberglass membrane layer over a polyester-reinforced membrane layer.

Specify Type II modified bitumen materials for all two-ply membrane installations, heavy-duty or high traffic service conditions and for all instances where fiberglass reinforced modified bitumen cap sheets are permitted.

- [c. SBS Base Sheet: [ASTM D 6162] [or] [ASTM D 6164] [or] [ASTM D 6163], Type [I or] II, Grade S, minimum 2.0 mm (80 mils) thick.]
- [d. SBS Interply Sheet: [ASTM D 6162] [or] [ASTM D 6164] [or] [ASTM D 6163], Type [I or] II, Grade S, minimum 2.0 mm (80 mils) thick.]

NOTE: Specify Grade S cap sheet only with the approval of the Government and when gravel surfacing or field applied coating is required in lieu of factory-applied mineral granule surfacing.

Specify 3.7 mm (145 mils) minimum thickness for SBS cap sheet unless directed otherwise by the Government.

- [e. SBS Cap Sheet: [ASTM D 6162] [or] [ASTM D 6164] [or] [ASTM D 6163]; Type II, Grade [G] [S], minimum [3.7 mm (145 mils)] [] thick at selvage edge, and as required to provide specified fire safety rating.]

NOTE: APP membrane materials are allowed on Army projects only. Delete APP on all other projects and in any case where torch application is not permitted.

- [f. APP Base Sheet: ASTM D 6222, Type I or II; or ASTM D 6223; Grade [G][S], minimum 3.5 mm (140 mils) thick at the selvage edge.]

NOTE: Specify Grade S cap sheet only with the approval of the Government and when gravel surfacing or field applied coating is required in lieu of factory-applied mineral granule surfacing.

Specify minimum 4 mm (160 mil) APP cap sheet thickness unless directed otherwise by the Government.

- [g.APP Cap Sheet: ASTM D 6222, Type II; or ASTM D 6223; Grade [G][S], minimum 4.0 mm (160 mils) thick at selvage edge.]

2.2 BASE FLASHING MEMBRANE

NOTE: Include metal clad flashing membrane option only where the foil surfacing will not create an aesthetic issue and reflectance of no concern. Do not specify foil surfaced materials for facilities along flight line.

Metal clad membrane flashing should not be considered effective grease protection for the flashing or roof membrane in areas where the roof may be exposed to cooking grease release. Lap areas remain susceptible to degradation from exposure to grease and solvents.

Membrane manufacturer's standard, minimum two-ply modified bitumen membrane flashing system compatible with the roof membrane specified and as recommended in membrane manufacturer's published literature. Flashing membranes shall meet or exceed the properties of the material standards specified for the modified bitumen [base][,interply] and cap sheet, except that flashing membrane thickness shall be as recommended by the membrane manufacturer.[Metal clad flashing membrane shall comply with ASTM D 6298].

[2.3 ASPHALT

NOTE: Include paragraph or bracketed requirement when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

ASTM D 312, Type III or IV, in accordance with modified bitumen membrane manufacturer requirements and compatible with the slope conditions of the installation.

] 2.4 COLD-APPLIED MEMBRANE ADHESIVE

NOTE: Materials standards and application requirements vary for cold applied membrane adhesives. Ensure product data and application instructions are included under "Submittals" when cold-process membrane applications are specified. This information will be referenced by the field personnel in monitoring the application process.

Consider low VOC adhesives for cold-process applications on occupied buildings and when otherwise necessary.

Membrane manufacturer's recommended [low volatile organic compound (VOC)] cold process adhesive for application of the membrane plies.

] 2.5 MEMBRANE SURFACING

NOTE: Coordinate surfacing requirements with the type of system specified in paragraph entitled "Description of Roof Membrane System". Factory-applied granule surfaced membrane shall be specified except under non-typical conditions where aggregate or coating applications may be considered. Factory-applied granules or aggregate surfacing should be used where possible. Specify required finished membrane surfacing. Delete other options.

Modified bitumen roof membrane cap sheet shall have factory-applied granule surfacing of [light][_____] color [as selected from membrane manufacturer's standard colors]. [Provide modified bitumen membrane manufacturer's recommended field-applied protective coating of [white][light gray][_____] color. [Aluminized coating shall comply with ASTM D 2824 or ASTM D 6848, Type I or III, as recommended by the modified bitumen roof membrane manufacturer].] [Light colored, opaque water-worn gravel aggregate surfacing material conforming to ASTM D 1863, or other aggregate as recommended by the membrane manufacturer and approved by the Contracting Officer[, and applied in flood coat of hot asphalt].]

] 2.6 PRIMER

ASTM D 41, or other primer compatible with the application and as approved in writing by the modified bitumen membrane manufacturer.

2.7 MODIFIED BITUMEN ROOF CEMENT

ASTM D 4586, Type II for vertical surfaces, Type I for horizontal surfaces, compatible with the modified bitumen roof membrane and as recommended by the modified bitumen 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).

Standard cant strips shall be of perlite conforming to ASTM C 728 [or woodfiber conforming to ASTM C 208] treated with bituminous impregnation, sizing, or waxing and fabricated to provide maximum 45 degree change in direction of membrane. Cant strips shall be minimum 38 mm (1-1/2 inches) thick 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. Kiln-dried preservative-treated wood cants, in compliance with requirements of Section 06100, "Rough Carpentry", shall be provided at base of wood nailers set on edge and wood curbing and where otherwise indicated.

2.9 FASTENERS AND PLATES

Coated, corrosion-resistant fasteners as recommended by the modified bitumen sheet manufacturer's printed instructions and meeting the requirements of FM AS 4470 and FM P7825c for Class I roof deck construction and the wind uplift resistance specified. For fastening of membrane or felts to wood materials, provide fasteners driven through 25 mm (1 inch) diameter 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.

2.9.1 Masonry or Concrete Walls and Vertical Surfaces

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, modified bitumen sheets, metal items, and accessories to masonry or concrete walls and vertical surfaces. Use power-driven fasteners only when approved in writing by the Contracting Officer.

2.9.2 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 AS 4470; not less than 50 mm (2 inches) in diameter. Discs shall be formed to prevent dishing or cupping.

[2.10 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 shall be manufacturer's standard for intended purpose, [comply with applicable specification section,] compatible with the membrane roof system and approved for use by the modified bitumen membrane manufacturer.

[2.10.1 Vapor Pressure Relief Vents

NOTE: Venting of roof insulation may be advisable

when vapor retarder is provided beneath insulation or in recover projects when the old roof membrane remains intact. The vapor retarder should be specified in Section 07220, "Roof and Deck Insulation." Coordinate with Section 06100, "Rough Carpentry," to ensure that kerfed wood nailers are specified at edge of roof insulation and placed around periphery. For roofs requiring venting that are more than 12 meters (40 feet wide), stack venting should be provided to supplement edge venting. Underside ventilation for steel decks should consist of continuous openings 3 mm to 5 mm (1/8 to 3/16 inch) wide between adjacent deck units. Coordinate these requirements with appropriate specification sections.

Vents shall be manufactured for the purpose of releasing vapor pressure from the roofing system by heat and pressure. Vents shall be one-way type design to prevent reverse flow of moisture laden air into roofing system. Valve cap shall effectively seal out wind-blown rain and snow and shall not permit water entry if submerged.

] [2.10.2 Pre-fabricated Curbs

Curbs shall be [_____] gauge [G90 galvanized] [AZ55 galvalume] [_____] with minimum 100 mm (4 inch) flange for attachment to roof nailers. Curbs shall provide minimum height of 250 mm (10 inches) above the finished roof membrane surface.

] [2.10.3 Elevated Metal [Walkways] [and] [Platforms]

As specified in Section [05500A MISCELLANEOUS METALS] [05500N METAL FABRICATIONS] .

] [2.11 WALKPADS

NOTE: Use walkpads as walkways and 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.

Roof walkpads shall be polyester reinforced, granule-surfaced modified bitumen membrane material, minimum [_____] [5 mm] ([_____] [200] mils) thick, compatible with the modified bitumen sheet roofing and as recommended by the modified bitumen sheet roofing manufacturer. Panels shall not exceed 1.2 meters (4 feet) in length. Other walkpad materials require approval of the Contracting Officer prior to installation.

] [2.12 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 inches) 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 inches) beyond all sides of surface bearing bases. Install walkpad material under all paver blocks.

] 2.13 ROOF INSULATION BELOW MODIFIED BITUMEN 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.

Insulation shall be compatible with the roof membrane, approved by the membrane manufacturer and as specified in Section 07220 ROOF AND DECK INSULATION.

] 2.14 MEMBRANE LINER

Self-adhering modified bitumen underlayment conforming to ASTM D 1970, EPDM membrane liner conforming to ASTM D 4637, or other waterproof membrane liner material as approved by the Contracting Officer.

PART 3 EXECUTION

3.1 EXAMINATION

Ensure that the following conditions exist prior to application of the roofing materials:

- a. [Drains,] [curbs,] [cants,] [control joints,] [expansion joints,] [perimeter walls,] [roof penetrating components,] [and] [equipment supports] are in place.
- b. Surfaces are rigid, clean, dry, smooth, and free from cracks, holes, and sharp changes in elevation. Joints in the substrate are sealed to prevent dripping of bitumen into building or down exterior walls.
- c. 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.
- d. Substrate is sloped as indicated to provide positive drainage.
- e. Walls and vertical surfaces are constructed to receive counterflashing, and will permit mechanical fastening of the base

flashing materials.

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

NOTE: Coordinate with Section 06100, "Rough Carpentry," to ensure that waterborne preservative treatment is specified for wood which will be in contact with roofing components.

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

- h. Cants are securely fastened in place in the angles formed by walls and other vertical surfaces. The angle of the cant is 45 degrees and the height of the vertical leg is not less than 89 mm (3-1/2 inches).

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

- [i. Venting is provided in accordance with the following:
 - [(1) Edge Venting: Perimeter nailers are kerfed across the 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.]
 - [(3) Vapor pressure relief vents: Holes equal to the outside diameter of vents are provided through the insulation where vents are required. Space vents in accordance with membrane manufacturer's recommendations.]]
- j. 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 or otherwise sealed to prevent air

leakage from the underside.]

- [k. 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.]
- [l. Cast-in-place substrates have been allowed to cure and the surface dryness requirements specified under paragraph entitled "Field Quality Control" have been met.]
- [m. Joints between precast concrete deck units are grouted, leveled, and stripped in with felt or bituminous stripping membrane set in bituminous cement prior to applying other roofing materials over the area.]

3.2 PREPARATION

3.2.1 Protection of Property

3.2.1.1 Protective Coverings

NOTE: Include bracketed requirement when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

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 inches, 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

NOTE: Include paragraph when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

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

] 3.2.2 Equipment

NOTE: Select equipment references as applicable to the project. Delete paragraphs that are not applicable.

[3.2.2.1 Mechanical Application Devices

Mount mechanical application devices on pneumatic-tired wheels. Use devices designed and maintained to 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

**NOTE: Include this requirement when torch-applied
modified bitumen sheet roofing is specified or when
torch application of base flashing is permitted.**

Torches and other open flame equipment shall be specifically designated for use in application of modified bitumen materials and approved by the modified bitumen sheet manufacturer. Open flame equipment shall not be ignited (burning) when left unattended. Provide and maintain a fire extinguisher adjacent to open flame equipment on the roof. Specific requirements for fire watches and burn permits exist. These requirements will be reviewed at the prerooting conference.

] 3.2.2.4 Electric-Heated Equipment

Provide adequate electrical service as required by manufacturer of electrical equipment to ensure against damage to equipment and property and to ensure proper application of roofing materials.

] [3.2.3 Heating of Asphalt

**NOTE: Include paragraph when hot-mopped membranes
are used or base sheets are hot-mopped to
non-nailable substrates.**

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. Kettles shall have visible working thermometer and thermostatic controls set to the temperature limits specified herein. 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 maximums specified, remove asphalt from the site. Do not permit cutting back, adulterating, or fluxing of asphalt.

] 3.2.3.1 Temperature Limitations for Asphalt

**NOTE: Include paragraph when hot-mopped membranes
are used or base sheets are hot-mopped to
non-nailable substrates.**

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) but not less than 204 degrees C (400 degrees F). 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.

]]3.2.4 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 modified bitumen sheet 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 applications.

3.2.4.1 Priming of Concrete and Masonry Surfaces

**NOTE: Include this paragraph when roofing and
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 membrane materials uniformly with primer.

3.2.4.2 Priming of Metal Surfaces

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

3.2.5 Membrane Preparation

Unroll modified bitumen membrane materials and allow to relax a minimum of 30 minutes prior to installation. In cold weather, adhere to membrane manufacturer's additional recommendations for pre-installation membrane handling and preparation. Inspect for damage, pinholes, particles of foreign matter, undispersed raw material, factory splices, or other conditions that might affect serviceability. Edges of seams shall be straight and flat so that they may be seamed to one another without forming fish mouths or wrinkles. Discard damaged or defective materials.

3.2.6 Substrate Preparation

Apply membrane to clean, dry surfaces only. Membrane shall not be applied to surfaces that have been wet by rain or frozen precipitation within the previous 12 hours. Provide cleaning and artificial drying with heated blowers or torches as necessary to ensure clean, dry surface prior to membrane application.

3.3 APPLICATION

Apply roofing materials as specified herein unless approved otherwise by the Contracting Officer. Keep roofing materials dry before and during application. 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 temperatures for asphalt. [Provide temporary roofing and flashing as specified herein prior to application of permanent roofing system.]

3.3.1 Phased Membrane Construction

Phased application of membrane plies is prohibited unless otherwise approved by the Contracting Officer and supported by the membrane manufacturer's written application instructions. Any delay in cap sheet installation shall 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

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

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 the building's 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 the permanent roofing system.

]3.3.3 Application Method

NOTE: Specify the applicable application method(s) and distinguish any varying requirements or options related to membrane and base flashing (e.g., in general manufacturer may allow base flashing membrane to be torched or set in cold adhesive on hot mopped roof membrane installations; however, this may or may not be desirable for a specific project installation.).

[3.3.3.1 Hot Asphalt Application of Modified Bitumen Membrane

NOTE: Include paragraph when hot-mopped membranes are used or base sheets are hot-mopped to non-nailable substrates.

Apply membrane immediately following application of hot asphalt. Apply hot asphalt within 2 meters (6 feet) of roll. Do not work ahead with asphalt. Asphalt shall be completely fluid, with mop temperatures within the asphalt's EVT range, but not less than 204 degrees C (400 degrees F), at the instant membrane comes into contact with asphalt. Application of bitumen between layers shall be such as to provide full, continuous, uniform coverage and complete contact of hot asphalt with the sheet above and below. Embed sheets in asphalt. As sheets are being rolled into hot asphalt, immediately and thoroughly apply uniform positive pressure by squeegee, roll, or broom to ensure full adhesion and lap seal, eliminate trapped air and to provide tight, smooth laminations. Avoid excessive extrusion of asphalt at lap areas. Control asphalt bleed out to approximately 25 mm (1 inch) maximum.

]3.3.3.2 Torch Applied [Heat Welded] Modified Bitumen Membrane [Flashing]

NOTE: Include the first bracketed sentence if base flashing may be torch-applied on hot mopped membrane work. Include requirement to roll lap areas with weighted roller when heat welding technique is specified.

Where heat welding is specified, coordinate with language in "Description of Roof Membrane System" and other parts of this specification.

[Base flashing membrane may be torch applied.] Ensure substrate membrane surfaces are warmed either naturally or by torch during the installation. Apply heat evenly to underside of roll membrane being installed and exposed side lap area of previously installed sheet. Provide for slight, uniform flow of bitumen in front of roll and full width of roll as the material is being rolled or set into place. Apply uniform positive pressure to ensure membrane is fully adhered and all laps are sealed. Prior to forming lap over granulated surfaces, embed granules of the receiving sheet by heating and troweling-in the granules to form a uniform black compound surface. [Roll all lap areas with a weighted roller immediately after forming lap. Provide for visual bleed out of compound in lap areas.][Avoid overheating the membrane or burning through to membrane reinforcement. Inspect and ensure all lap areas are fully sealed.]

[3.3.3.3 Cold Adhesive Applied Modified Bitumen Membrane

Apply cold adhesive with airless sprayer or 6 mm (1/4-inch) saw-toothed rubber squeegee to prepared surfaces in accordance with membrane manufacturer's application instructions. Fully cover substrate with adhesive. Roll or lay membrane in adhesive in accordance with manufacturer's recommendations and within the time limitations of adhesive application. Broom the membrane to ensure full contact with adhesive. Seal laps with adhesive or by heat fusing with torch or hot air welder as required by membrane manufacturer. Minimize traffic on installed membrane during the adhesive cure and set time.

] [3.3.4 Ventilating Base Sheets

NOTE: Include this paragraph when ventilating base

sheets are specified in the paragraph entitled "Description of Roof Membrane System" and in the absence of rigid board roof insulation. Include mechanical attachment or top mop requirements as applicable. Where rigid board roof insulation is a component of the roof system, ventilating base sheets should be specified in the roof insulation section 07220.

Apply ventilating base sheets with 75 mm (3 inch) side laps and 150 mm (6 inch) end laps in accordance with manufacturer's printed application instructions for substrate [and wind uplift conditions]specified.
[Mechanical attachments shall be as required for wind resistance specified and to include increased frequency of attachment at corner and perimeter areas. Drive fasteners flush with no dishing or cupping of fastener plate.] [Top mop perforated sheet with a full, continuous mopping of hot asphalt.]

]3.3.5 [Fiberglass Felt] [Modified Bitumen] Base Sheet

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 one 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. [Spot adhesion shall be with hot asphalt applied in 300 mm (12 inch) diameter spots installed in two staggered rows, centered 300 mm (12 inches) in from edge of the base sheet.] [Apply cold adhesive with airless sprayer or a 6 mm (1/4-inch) saw-toothed rubber squeegee and at application rate recommended by the membrane manufacturer. Fully cover substrate with cold adhesive. Ensure laps areas of base sheet are fully sealed.] Roll and broom in the base sheet to ensure full contact with the [hot asphalt] [adhesive] 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 inches) unless greater side lap is recommended by the manufacturer's standard written application instructions. Provide end laps of not less than 150 mm (6 inches) and staggered a minimum of 1 meter (36 inches). 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 inches) 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 inches) 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. Application shall be free of ridges, wrinkles, and buckles.

3.3.6 Modified Bitumen Membrane Application

NOTE: On slopes up to 1:6 (2 inches per foot), specify membrane application perpendicular to slope of roof. On slopes greater than or equal to 1:6 (2 inches per foot), specify membrane application parallel to roof slope.

Ensure proper sheet alignment prior to installation. [Apply membrane layers perpendicular to slope of roof in shingle fashion to shed water, including application on areas of tapered insulation that change slope direction.] [Apply membrane layers parallel to slope of roof.] Bucking or backwater laps are prohibited. Fully adhere membrane sheets to underlying substrate materials. Provide minimum 75 mm (3 inch) side laps and minimum 150 mm (6 inch) end laps and as otherwise required by membrane manufacturer. Stagger end laps minimum one meter (36 inches). Offset side laps between membrane layers a minimum of 300 mm (12 inches). Offset end laps between membrane layers a minimum of one meter (36 inches). All membrane layers shall be installed the same workday, unless supported otherwise by roof membrane manufacturer application instructions and approved by the Contracting Officer. Provide tight smooth laminations of each membrane layer without wrinkles, ridges, buckles, kinks, fishmouths, or voids. Ensure full membrane adhesion and full lap seals. Rework to seal any open laps prior to application of subsequent membrane layers. The completed membrane application shall be free of surface abrasions, air pockets, blisters, ridges, wrinkles, buckles, kinks, fishmouths, voids, or open seams.

3.3.6.1 Cap Sheet Installation

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. Torch application of cap sheet may reduce instances of cap sheet blistering.

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

Underlying applied membrane shall be inspected and repaired 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. Do not apply cap sheet if rain or frozen precipitation has occurred within the previous 24 hours. Align cap membrane and apply by the specified method with the proper side and end lap widths. [Cap sheet may

be set in hot asphalt or torch applied 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][adhesive] bleed out while the [asphalt is still hot][adhesive is still tacky].] Minimize traffic on newly installed cap sheet membrane.

[3.3.6.2 Backnailing of Cap Sheet

NOTE: Include this paragraph for roof slopes greater than or equal to 1:6 (2 inches per foot). Coordinate with insulation Section 07220 and nailer requirements Section 06100 to allow for backnailing of the membrane.

Unless otherwise recommended by the modified bitumen 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 feet) on center unless approved otherwise by the Contracting Officer. Coordinate the nailer installation with insulation requirements. 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 inches) on center across the width of the sheet in a staggered fashion. Nails shall have 25 mm (1 inch) diameter metal cap or be nailed through 25 mm (1 inch) diameter caps. Cover nails by overlapping adjacent upslope sheet at the end lap area.

]3.3.7 Membrane Flashing

Apply two-ply modified bitumen 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. Apply membrane flashing in accordance with the roof membrane manufacturers printed instructions and as specified. 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 modified bituminous base flashing 150 mm (6 inches) on center through minimum 25 mm (1 inch) diameter tin caps with fasteners of sufficient length to embed minimum one inch into attachment substrate. [Apply matching granules in any areas of [asphalt][adhesive] bleed out while the [asphalt is still hot][adhesive is still tacky].] 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. Metal flashing are specified under Section 07600 FLASHING AND SHEET METAL.

3.3.7.1 Membrane Strip Flashing

Set primed flanges of metal flashings in full bed of modified bituminous cement material and securely fasten through to attachment substrate. Strip-in with membrane flashing so that strip extends not less than 100 mm (4 inches) beyond outer edge of flange. Where multiple membrane stripping

plies are installed, extend each additional stripping ply minimum 100 mm (4 inches) beyond edge of previous ply.

[3.3.7.2 Membrane Flashing at Roof Drain

NOTE: Include this paragraph when roof drains are indicated.

Roof drains are specified in Section 15400N PLUMBING SYSTEMS. Flashing for roof drains, are specified in Section 07600 FLASHING AND SHEET METAL. Extend membrane sheets to edge of drain bowl opening at the roof drain deck flange in accordance with membrane manufacturer's printed application instructions. Securely clamp membrane sheets and metal roof drain flashing and strip flashing in the flashing clamping ring. Secure clamps so that sheets and metal flashing are free from wrinkles and folds. Trim stripping flush with inside of clamping ring.

] [3.3.7.3 Pre-fabricated Curbs

Prefabricated curbs shall be securely anchored to nailer or other base substrate and flashed with modified bitumen membrane.

] 3.3.7.4 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. Specific method of installing set-on accessories must 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.

3.3.7.5 Lightning Protection

Lightning protection system components shall be flashed or attached to the roof membrane in a manner acceptable to the roof membrane manufacturer.

3.3.8 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.

[3.3.9 Elevated Metal [Walkways] [and] [Platforms]

Install over completed roof system in accordance with Section 05500. Provide protection mat of walkpad material, or other material approved by the Contracting Officer, at all surface bearing support locations.

] 3.3.10 Paver Blocks

Install paver blocks where indicated and as necessary to support surface bearing items traversing the roof area. Paver block shall be set on a layer of walkpad [or cap sheet] applied over the completed roof membrane.

[3.3.11 Vapor Pressure Relief Vents

NOTE: Include this paragraph only where vapor pressure relief venting over wet fill substrate material or insulation over vapor retarder is required. Coordinate with venting provisions in other paragraphs of this specification.

Provide vents in a uniform pattern and at a minimum rate of one for each 100 square meters (1000 square feet) of roof area. Space and install in strict accordance with manufacturer's instructions. Cut a hole, of diameter to suit base opening size of vent, through the roofing membrane and down to the deck[vapor retarder] surface. Fill the cut out with loose fill fiberglass or crumbled polyisocyanurate insulation. Set vent flange over hole on top of roofing membrane in a 1/8 inch thick bed of modified bitumen roof cement or special adhesive or cement recommended by vent manufacturer. Strip-in vent flanges with strip flashing membrane and provide bead of modified bitumen sealant at membrane termination at base of vent.

] [3.3.12 Field Applied Surfacing

NOTE: Delete "Field Applied Surfacing" and associated paragraphs if factory-applied granule surfaced membrane is specified. Otherwise, include only the applicable surfacing, delete all others.

After completion of roof membrane and flashing installation, and correction of tears, gouges, and other deficiencies in the installed work, apply specified surfacing.

[3.3.12.1 Aggregate

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 or 14.5 kg (300 pounds) per square for slag or other approved aggregate surfacing. Provide for full and uniform coverage of the roof surface. Approximately 50 percent of the aggregate shall be solidly adhered in the asphalt.

] [3.3.12.2 Coating Application

Apply surface coating materials to membrane and flashing in accordance with coating material manufacturer's recommendations.

] [3.3.13 Correction of Deficiencies

Where any form of deficiency is found, additional measures shall be taken as deemed necessary by the Contracting Officer to determine the extent of the deficiency and corrective actions shall be as directed by the Contracting Officer.

3.3.14 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

At the end of the day's work and when precipitation is imminent, protect applied modified bitumen roofing system from water intrusion.

[3.4.1 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 cut-offs to expose the insulation when resuming work, and remove the insulation sheets used for fill-in.

]3.4.2 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.

3.4.3 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.

3.5 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

**NOTE: Include paragraph or bracketed requirement
when hot-mopped membranes are used or base sheets
are hot-mopped to non-nailable substrates.**

Before application of membrane sheets 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 membrane 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), shall not foam upon contact.

- b. Strippability: On cementitious substrate surfaces, 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.

]3.5.2 Construction Monitoring

During progress of the roof work, Contractor shall make visual inspections as necessary to ensure compliance with specified parameters. Additionally, verify the following:

Materials comply with the specified requirements.

- a. Materials are not installed in adverse weather conditions.

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

- b. Equipment is in working order. Metering devices are accurate.

- 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.

Membrane heating, hot mopping, or adhesive application is provided uniformly and as necessary to ensure full adhesion of roll materials. Asphalt is heated and applied 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.

Lap areas of all plies are full sealed.

Membrane is fully adhered 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

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.

Manufacturer's technical representative shall 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. [Inspections shall occur during the first 20 squares of membrane installation, at mid-point of the installation, and at substantial completion, at a minimum. Additional inspections shall 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 shall be performed as requested by the Contracting Officer.] After each inspection, a report, signed by the manufacturer's technical representative shall be submitted to the Contracting Officer within 3 working days. The report shall note overall quality of work, deficiencies and any other concerns, and recommended corrective action.

]3.5.3 Samples of Roofing

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.

Take 100 mm by 1000 mm (4-inch by 40-inch) cut samples across width of modified bitumen sheets as directed by the Contracting Officer. Cut samples will be examined by the Contracting Officer for specified number of plies, proper lap width, complete lap seal, full uniform adhesive compound application and adhesion, full bond between plies, harmful foreign materials, presence of moisture, and wet insulation. Where cuts are not retained by the Contracting Officer or disposed, set cut strip back in cut area in bed of modified bitumen cement. Repair area of cut with new minimum two-ply modified bitumen membrane patch.

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 completing roofing but prior to Government acceptance, perform the following test for watertightness. Plug roof drains and fill with water to edge of drain sump for 8 hours. Do not plug secondary overflow drains at the 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 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

**NOTE: This optional requirement should be included
only under special circumstances and on roof systems
conductive to effective infrared scanning, or as
otherwise instructed.**

[Eight] [_____] months after completion of the roofing system, the Contractor shall inspect the roof surface using infrared (IR) scanning as specified in ASTM C 1153. Where the IR inspection indicates moisture intrusion, wet insulation and damaged or deficient materials or construction shall be replaced in a manner to provide watertight construction and maintain the specified roof system warranties.

]3.7 INSTRUCTIONS TO GOVERNMENT PERSONNEL

Furnish written and verbal instructions on proper maintenance procedures to designated Government personnel. Furnish instructions by a competent representative of the modified bitumen membrane manufacturer and include a minimum of 4 hours on maintenance and emergency repair of the membrane. Include a demonstration of membrane repair, and give sources of required special tools. Furnish information on safety requirements during maintenance and emergency repair operations.

3.8 INFORMATION CARD

For each roof, furnish a typewritten information card for facility Records and a card laminated in plastic and framed for interior display at roof access point, or a photoengraved 1 mm (0.032) inch thick aluminum card for exterior display. Card shall be 215 mm by 275 mm (8 1/2 by 11 inches) minimum. Information card shall identify 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. The card shall be a minimum size of 215 mm by 275 mm (8 1/2 by 11 inches). 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 --