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Change 4 - 02/23

Preparing Activity: NAVFAC | Superseding
UFGS-07 57 13 (August 2010)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 07 57 13

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SECTION 07 57 13
SPRAYED POLYURETHANE FOAM (SPF) ROOFING

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****
NOTE: This guide specification covers the requirements for spray applied urethane foam roofing systems with a fluid applied elastomeric protection coating.

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: Slope roof to drain, with minimum slope after deflection of 20 mm per meter 1/4 inch per foot. Roof slope will be obtained by sloping the structural deck and not by varying the thickness of the sprayed insulation. Do not apply the roofing system when deck is of lightweight concrete or when other than light foot traffic is anticipated on the roof. Broomed finish should be specified for concrete decks.

The designer will determine the minimum required R-value and calculate the insulation thickness based on the aged R-value of 5.6. Specify or indicate insulation thickness on drawings with minimum thickness not less than 38 mm 1-1/2 inches.

Coordinate this section with other system components specifications such as decking and sheet metal flashing. Also coordinate this section with the criteria of UFC 3-110-03, "Roofing" as it relates to the specific project and Service Exceptions indicated therein.

****

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.

****

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 INDUSTRIAL HYGIENE ASSOCIATION (AIHA)

AIHA Z88.6	(2006) Respiratory Protection - Respirator Use-Physical Qualifications for Personnel

ASTM INTERNATIONAL (ASTM)

ASTM C177	(2019; E 2023) Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus
ASTM C273/C273M	(2020) Standard Test Method for Shear Properties of Sandwich Core Materials
ASTM C518	(2021) Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
ASTM D56	(2016a) Standard Test Method for Flash

	Point by Tag Closed Cup Tester
ASTM D93	(2019) Standard Test Methods for Flash-Point by Pensky-Martens Closed Cup Tester
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D570	(1998; E 2010; R 2010) Standard Test Method for Water Absorption of Plastics
ASTM D579/D579M	(2015) Standard Specification for Greige Woven Glass Fabrics
ASTM D624	(2000; R 2020) Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers
ASTM D822	(2013; R 2018) Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings
ASTM D1621	(2016) Standard Test Method for Compressive Properties of Rigid Cellular Plastics
ASTM D1622/D1622M	(2014) Apparent Density of Rigid Cellular Plastics
ASTM D1623	(2017) Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics
ASTM D2126	(2020) Response of Rigid Cellular Plastics to Thermal and Humid Aging
ASTM D2240	(2015; E 2017) Standard Test Method for Rubber Property - Durometer Hardness
ASTM D2697	(2003; R 2014) Volume Nonvolatile Matter in Clear or Pigmented Coatings
ASTM D2842	(2019) Water Absorption of Rigid Cellular Plastics
ASTM D5469/D5469M	(2012) Application of New Spray Applied Polyurethane Foam and Coated Roofing Systems
ASTM D6226	(2021) Standard Test Method for Open Cell Content of Rigid Cellular Plastics
ASTM E84	(2023) Standard Test Method for Surface Burning Characteristics of Building Materials
ASTM E96/E96M	(2022a; E 2023) Standard Test Methods for

	Gravimetric Determination of Water Vapor Transmission Rate of Materials
ASTM G154	(2023) Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Materials
ASTM G155	(2021) Standard Practice for Operating Xenon Arc Lamp Apparatus for Exposure of Materials

FM GLOBAL (FM)

FM APP GUIDE	(updated on-line) Approval Guide http://www.approvalguide.com/

INTERNATIONAL SAFETY EQUIPMENT ASSOCIATION (ISEA)

ANSI/ISEA Z87.1	(2020) Occupational and Educational Personal Eye and Face Protection Devices

NATIONAL ROOFING CONTRACTORS ASSOCIATION (NRCA)

NRCA RoofMan	(2020) The NRCA Roofing Manual

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

SPRAY POLYURETHANE FOAM ALLIANCE (SPFA)

SPFA AY-104	(1994; R 2008) Spray Polyurethane Foam Systems for New and Remedial Roofing

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 1256	(2002; Reprint Jul 2013) Fire Test of Roof Deck Constructions
UL Bld Mat Dir	(updated continuously online) Building Materials Directory

1.2 DESCRIPTION OF ROOF SYSTEM

****
NOTE: Granules will be used only where appearance of roof is important and for walkways.
****

Provide a roofing system consisting of sprayed in-place polyurethane foam roof insulation covered with a waterproof elastomeric protective coating[

and surfaced with ceramic granules[in areas indicated]].

1.2.1 Design Requirements

1.2.1.1 Fire and Wind Uplift

****

NOTE: Specify roofing over a metal deck with either a UL 1256 classification or an FM Class I listing in addition to UL 790. Specify UL 790 Class A fire rating for all applications of less than 1:4 slope. Slope greater than 1:4 may require Class B rating based on flame spread on steeper slope.

Factory Mutual (FM) 1-90 wind uplift is the minimum recommendation for all spray foam roofing applied directly to deck substrates. The wind rating of sprayed foam applied to an existing roof system is typically the same as the rating of the existing roof system.

****

[Provide a complete roof system having a[UL 1256,] UL 790, Class A[or B] fire rating, be listed as "fire classified" in UL Bld Mat Dir, and bearing the UL label or be listed as a Class 1 Roof Deck in FM APP GUIDE.][Provide roof system over steel deck rated as Class 1-[90][_____] in accordance with FM APP GUIDE.] Ratings from other independent laboratories may be substituted provided that the tests, requirements and ratings are documented to be equivalent, to the satisfaction of the Contracting Officer.

1.2.2 Performance Requirements

Provide an installed roof system that is watertight; free of defects including foam and coating delamination, blistering, or voids; suitable for the climatic and service conditions of the installation; and providing positive drainage of the roof area.

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

Spray Urethane Foam; G[, [_____]]

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

Protective Coating; G[, [_____]]

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

Primer

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

Sealants

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

[Mineral Granules]

Submit literature including material description, physical properties, recommended storage conditions, Safety Data Sheets, and shelf life expiration date.

[Heat Island Reduction; S

][Energy Star Label for Top Coating; S

] Blowing Agent

SD-04 Samples

Sprayed Polyurethane Foam Roof System Mock-Up; G[, [_____]]

Sample Warranty; G[, [_____]]

SD-06 Test Reports

Core Sample Tests; G[, [_____]]

Provide [_____] copies of test reports.

SD-07 Certificates

Qualification of Manufacturer; G[, [_____]]

Qualification of Applicator; G[, [_____]]

SD-08 Manufacturer's Instructions

Spray Urethane Foam

Protective Coating

Polyurethane foam; G[, [_____]]

Submit manufacturer's complete application instructions and details, and to include storage, handling, and warnings or precautions on flammability and toxicity. Include manufacturer's written recommendations for primers and for surface preparation of metals, concrete, roofing, and other materials and surface substrates over which sprayed polyurethane foam and coating system will be applied.

Roof coating; G[, [_____]]

Submit manufacturer's complete application instructions and details, and to include storage, handling, and warnings or precautions on flammability and toxicity. Include manufacturer's written recommendations for primers and for surface preparation of metals, concrete, roofing, and other materials and surface substrates over which sprayed polyurethane foam and coating system will be applied.

Primers; G[, [_____]]

Submit manufacturer's complete application instructions and details, and to include storage, handling, and warnings or precautions on flammability and toxicity. Include manufacturer's written recommendations for primers and for surface preparation of metals, concrete, roofing, and other materials and surface substrates over which sprayed polyurethane foam and coating system will be applied.

Surface preparation; G[, [_____]]

Submit manufacturer's complete application instructions and details, and to include storage, handling, and warnings or precautions on flammability and toxicity. Include manufacturer's written recommendations for primers and for surface preparation of metals, concrete, roofing, and other materials and surface substrates over which sprayed polyurethane foam and coating system will be applied.

SD-09 Manufacturer's Field Reports

Daily Log; G[, [_____]]

Submit at completion of each day's work, including a record of each day's wet bulb and dry bulb temperature readings, substrate temperature readings, humidity readings, wind speed, and time of readings, wet film thickness measurements and their location, and quality control inspection observations. Include slit and core sample information as a part of the daily log. Mark area foamed and locate slit and core samples on roof plan and submit with daily log.

SD-11 Closeout Submittals

Warranty; G[, [_____]]

Information Card; G[, [_____]]

1.4 QUALITY ASSURANCE

1.4.1 Qualification of Manufacturer

****
NOTE: Specify 10 years manufacturer experience unless directed otherwise by the Government.
****

Sprayed polyurethane foam and elastomeric coating products manufacturer must have a minimum of [10][_____] years experience in the manufacture of polyurethane foam and elastomeric coating products.

[1.4.1.1 Manufacturer's Technical Representative

****
NOTE: Include this paragraph where manufacturer inspection is required.
****

Manufacturer's technical representative must have a minimum of 10 years experience with sprayed polyurethane roof systems products and installations and be thoroughly familiar with the products to be installed, installation requirements and practices, quality control of the installation, and with any special considerations in the geographical area and climate where construction will take place. The representative must be available to perform field inspections and attend meetings as specified.

]

1.4.2 Qualification of Applicator

****

NOTE: Specify 5 years as an approved contractor unless directed otherwise by the Government.
****

The roof system applicator must have prior manufacturer training in the application of sprayed polyurethane foam and coating materials. Applicator must be certified and approved by the foam and coating manufacturer to apply the specified materials and provide the specified manufacturer warranty. Applicator must have a minimum of [5][_____] years experience in application of the specified materials and minimum of [10][_____] years experience in the application of sprayed polyurethane foam roof systems. Mechanics applying the foam and coating materials must have minimum 3 years prior experience in handling and spraying the type of materials specified and spray equipment must be operated by or under the direct full-time supervision of manufacturer-trained personnel. The applicator must 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 Preroofing Conference

After approval of submittals and before performing roofing 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 representative;

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

e. Quality control plan for the roof system installation;

f. Property protection measures.

g. Safety requirements.

Coordinate and schedule a preroofing conference coordinated with the Contracting Officer and attended by the Contractor, the Contracting Officer's designated personnel, personnel directly responsible for the installation of roof system, related sheet metal work, [[mechanical][and][electrical] work], other trades interfacing with the roof work, and a representative of the sprayed polyurethane foam 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.

1.4.4 Foam Roof System Mock-Up

Apply the spray foam roofing system, including the specified elastomeric protective coating, in a designated test area of not less than 4 square

meters 50 square feet. Notify the Contracting Officer a minimum of 48 hours prior to the test application. Include a drain and wall and perimeter flashing into the test area. Include in the test area the applicable roofing details, the requirements of surface texture, foam adhesion, and adhesion of the roof coating to the foam. Use the same equipment in the construction that is used in the application of the test roof system.

1.4.5 Sample Warranty

Submit sample warranty for the complete roof system meeting the specified warranty requirements. Sample warranty must be submitted and approved by the Contracting Officer prior to commencement of roof work.

1.5 DELIVERY, STORAGE, AND HANDLING

1.5.1 Delivery

Deliver and store materials in sufficient quantity to allow for uninterrupted flow of work. Deliver materials to the jobsite in their original unopened packages, clearly marked with the manufacturer's name, brand name, description of contents, and shelf life of containerized materials.

1.5.2 Storage

Store materials in clean, dry areas, away from excessive heat, sparks, and open flame. Ventilate the storage area to prevent build-up of flammable gases. Maintain temperatures in the storage area below the materials' flash point and within limits recommended by the manufacturer's printed instructions.

1.5.3 Handling

Handle materials and containers during application work safely and in accordance with manufacturer recommendations. Store liquids in airtight containers and keep containers closed except when removing materials. Do not use equipment or containers containing remains of dissimilar materials. Do not expose foam component containers to direct sunlight for periods of time sufficient to cause contents to exceed 26 degrees C 80 degrees F. Mark and remove from job site materials which have been exposed to moisture or that exceed shelf life limits. Not more than half the shelf life must have expired when materials are applied.

1.6 ENVIRONMENTAL CONDITIONS

Do not apply roof system materials during inclement weather or when ice, frost, surface moisture, or visible dampness is present on the surface to be covered, or when precipitation is imminent. Use moisture-measuring methods and equipment as required to verify that the moisture conditions of substrate surfaces are in accordance with roof system materials manufacturer requirements prior to application of foam and coating materials. Verify substrate temperatures are within limits recommended by the manufacturer's printed instructions, unless specified otherwise. Use wind screen protection for all spray applications when wind speeds exceed 10 miles per hour.

1.6.1 Primer

Follow manufacturer's printed application and curing instructions, except that no primer can be applied when ambient temperature is below 4 degrees C 40 degrees F or when ambient temperature is expected to fall below 2 degrees C 35 degrees F during drying or curing period. Select primer material and color to promote proper substrate temperature for sprayed polyurethane foam application.

1.6.2 Sprayed Polyurethane Foam

Suspend foam spraying when wind speeds exceed 40.23 kilometers per hour 25 miles per hour. Do not apply sprayed polyurethane foam if the roof surface temperature is less than 10 degrees C 50 degrees F, higher than 54 degrees C 130 degrees F, or is less than 3 degrees C 5 degrees F above the dewpoint. Verify relative humidity is within limits recommended by the sprayed polyurethane foam manufacturer's printed instructions. Determine the dewpoint at the jobsite prior to and upon completion of each work day unless variable weather conditions require more frequent monitoring. Verify the wet bulb and dry bulb temperatures during application of sprayed polyurethane foam are within the ranges recommended by the sprayed polyurethane foam manufacturer. Take wet bulb and dry bulb temperatures at the beginning of foaming, end of foaming, and at 2 hour intervals during foaming. Record each wet bulb and dry bulb temperature reading, substrate temperature, wind speed, humidity, time of reading, and date, and area foamed on a copy of the roof plan and submit with daily log to the Contracting Officer.

1.6.3 Elastomeric Coating

Prior to applying coating, check polyurethane foam with a moisture resistance meter to ensure that foam is dry. Apply roof coating between the temperature ranges of 10 and 43 degrees C 50 and 110 degrees F, ambient.

1.7 COORDINATION

Coordinate roofing operations with work of other trades to ensure that components are installed as required to permit continuous self-flashing of the sprayed polyurethane foam and protective coating system. Protect the installed roofing system from damage. Repair any damaged areas.

[1.7.1 Flashing

Metal flashing guidelines and standards are specified under Section 07 60 00FLASHING AND SHEET METAL. Provide flashing shop drawing submittal requirements of Section 07 60 00 FLASHING AND SHEET METAL as a part of the submittal requirements of this section.

]1.8 WORK SEQUENCE

Schedule the work in order to prevent using newly constructed roofing for storage, walking surface, or material or equipment movement. If access is necessary, protect new roofing surfaces, flashings, and mechanical equipment. Repair damage which does occur and notify the Contracting Officer within 24 hours of the repairs.

1.9 FOAM SPRAY EQUIPMENT

1.9.1 Applicator

Use an airless foam spray gun of the mechanical, self-cleaning type, that does not require a flushing solvent during the spray operation.

1.9.2 Equipment Calibration

Fully calibrate the foam metering equipment to monitor each liquid component to within 2 percent of the foam material manufacturer's required metering ratio. Calibrate spray equipment each day at start of operations, after each restart if spraying operations have been terminated for more than one hour, whenever there is a change in fan pattern or pressure, whenever slow curing areas are noticed, whenever a change is made in hose length or working height, and after changeover between materials. Verify and demonstrate the calibration of equipment is adjusted to deliver components in proper mix and proportion. Complete calibration on cardboard or plywood on the roof adjacent to the area to be sprayed.

1.9.3 Metering Equipment Requirements

Use foam metering equipment capable of developing and maintaining the foam manufacturer's required liquid component pressures and temperatures. Foam metering equipment must have gages for visual monitoring. Verify the equipment is within the temperature control of foam components and within the temperature ranges recommended by the foam manufacturer's printed instructions.

1.9.4 Moisture Protection

Protect the surfaces of component supply containers or tanks used to feed the foam metering equipment from moisture.

1.9.5 Compressed Air

Supply compressed air in contact with foam components during mixing or atomization through moisture traps that are continuously bled.

1.9.6 Dispense Excess Materials

Do not deposit materials used for cleaning of equipment or materials dispensed for calibration purposes and establishment of spray gun pattern on the roof surfaces to be sprayed. Dispense such materials into scrap containers or onto plastic film, or cardboard, and dispose of in compliance with safety requirements and jobsite regulations.

1.10 SPECIAL SAFETY PROVISIONS

During application, use the following instructions or equipment unless these are in conflict with the manufacturer's recommendations or requirements of a recognized legal authority, in which case, the manufacturer's recommendations or the legal authority's requirements take precedence:

1.10.1 Special Equipment

1.10.1.1 Air Masks

Wear fresh air supply masks when applying foam or when handling hazardous liquid materials. Use respiratory protective devices as recommended by AIHA Z88.6. Instruct personnel required to use respiratory protective devices in the use of the devices. Maintain such equipment and inspect regularly.

1.10.1.2 Eye and Face Masks

Use eye and face protection during materials application. Use eye and face protective equipment meeting the requirements of ANSI/ISEA Z87.1.

1.10.1.3 Clothing and Gloves

Wear protective clothing and gloves during materials application. Where skin areas are not covered by clothing, protect those areas by using protective creams.

1.10.2 Handling Precautions

1.10.2.1 Venting of Material Containers

Partially unscrew material container and drum caps to gradually vent the containers prior to opening. Do not inhale vapors. Decontaminate empty component containers by filling with water and allowing to stand for 48 hours with bung caps removed. Under no circumstances seal, stop, or close the containers which have been emptied of the foam component.

1.11 WARRANTY

Provide roof system material and workmanship warranties meeting specified requirements. Where project specific requirements require revision or amendment to the standard manufacturer warranty, provide written revisions and amendments to the Contracting Officer.

1.11.1 Roof System Manufacturer Warranty

****
NOTE: Specify 10 year warranty unless directed otherwise by the Government.
****

Furnish a single-source roof system manufacturer's [_____][10]-year no dollar limit materials and installation workmanship warranty, for a watertight roof system construction. Provide warranty directly to the Government and commence warranty date at time of Government's acceptance of the roof work. The warranty must 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 into the roof system, blisters, cracks, ruptures, splits, delaminates, disbonds, or shows evidence of excessive weathering due to defective materials or installation workmanship, the repair or replacement of the defective and damaged foam and coating materials of the roof system and correction of defective workmanship is the

responsibility of the spray foam and coating manufacturer. All costs associated with the repair or replacement work are the responsibility of the 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 does not void the warranty.

1.11.2 Roofing System Installer Warranty

The roof system installer must 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 foam and coating applications, flashing, accessories, attachments, and sheet metal installation. Write the warranty directly to the Government. Correction of defective workmanship and replacement of damaged or affected materials is the responsibility of the roof system installer. All costs associated with the repair or replacement work are the responsibility of the installer.

1.11.3 Continuance of Warranty

Repair or replacement work that becomes necessary within the warranty period must be approved, as required, and accomplished in a manner so as to restore the integrity of the roof system assembly and validity of the manufacturer warranty for the remainder of the manufacturer warranty period.

1.12 CONFORMANCE AND COMPATIBILITY

The entire roofing and flashing system must be 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 applicable recommendations of the NRCA Roofing and Waterproofing Manual, reference standards, 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.

PART 2 PRODUCTS

2.1 MATERIALS

Coordinate with other specification sections related to the roof work. Furnish a combination of specified materials that comprise a roof system acceptable to the roof membrane manufacturer and meeting specified requirements. Protect materials provided from defects and make suitable for the service and climatic conditions of the installation.

2.2 SPRAY URETHANE FOAM

Provide urethane foam as the standard product of the manufacturer, and in containers that are factory marked with the manufacturer's name or trademark. Provide foam material that is a formulation suitable for the environmental and climatic conditions in which foam is applied. Provide urethane foam meeting the following requirements:

Blowing Agent Products that contain hydrochlorofluorocarbons (HCFCs), chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs), or other blowing

agent with Ozone Depletion Potential (ODP) greater than 0.015 or Global Warming Potential (GWP) above 17 are prohibited. For a list of foam blowing agents with ODP and GWP values see https://www.epa.gov/snap/substitutes-rigid-polyurethane-spray.

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Density (Sprayed in Place)	ASTM D1622/D1622M	48 (minimum)	kg/m3
K-Factor (aged)	ASTM C177 ASTM C518	1800 (maximum)	J per square meter/hr; degrees C per 25 mm
Compressive Strength Parallel to Foam Rise	ASTM D1621	290 (minimum)	kPa
Shear Strength	ASTM C273/C273M	275 (minimum)	kPa
Tensile Strength Parallel to Foam Rise	ASTM D1623	414 (minimum)	kPa
Dimensional Stability (Humid Aging)7 days volume change 71 degrees C, 100 relative humidity	ASTM D2126	6 (maximum)	percent net
Water Vapor Permeability	ASTM E96/E96M	4.35 by 10-9 (maximum)	G/Pa m2
Closed Cell Content	ASTM D6226	90 (minimum)	percent by volume
Water Absorption	ASTM D2842	0.49 (maximum)	kg/m2
Flammability	ASTM E84	Flame spread of 75 or less	---

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Density (Sprayed in Place)	ASTM D1622/D1622M	3.0 (minimum)	lb./ft3

Properties in Inch-Pound Units			
K-Factor (aged)	ASTM C177 ASTM C518	0.15 (maximum)	BTU per SF/hr; degrees F per inch
Compressive Strength Parallel to Foam Rise	ASTM D1621	42 (minimum)	lb/in2
Shear Strength	ASTM C273/C273M	40 (minimum)	lb/in2
Tensile Strength Parallel to Foam Rise	ASTM D1623	60 (minimum)	lb/in2
Dimensional Stability (Humid Aging)7 days volume change 160 degrees F, 100 relative humidity	ASTM D2126	6 (maximum)	percent net
Water Vapor Permeability	ASTM E96/E96M	3.0 (maximum)	per inch
Closed Cell Content	ASTM D6226	90 (minimum)	percent by volume
Water Absorption	ASTM D2842	0.10 (maximum)	lb./ft2
Flammability	ASTM E84	Flame spread of 75 or less	---

2.3 PROTECTIVE COATING

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NOTE: Refer to Society of Plastics Industry publication AY 102, "A Guide for Selection of Elastomeric Protective Coatings Over Sprayed Polyurethane Foam" for information regarding coatings selection. Include only the required coating type(s). Delete other options.

In general roof coatings designated as Types A and B are equally acceptable and should be included as Contractor options where roof slopes are 1/2:12 or greater. Coating Type CB may be used as the total coating system (base, intermediate, and finish) or may be used as base and intermediate with Type CF as finish coat. Coating Type CF should only be used as finish coat. Systems using type CB as total or a combination of Types CB and CF may be used for any slope.

SELECTION GUIDANCE TABLE		
COATING DESCRIPTION	**PERFORMANCE FEATURES**	**RECOMMENDED APPLICATIONS**
Type A(Silicone) One component system. High permeability (breathable). Good weatherability. Withstands temperature extremes well. Use on slopes 1:24 (1/2:12) and greater. Typical 4-8 hour cure time. Use dark base coat. Available in off white, tan, shades of gray.		
Type B(Silicone) Two component system. High permeability (breathable). Use on slopes 1:24 (1/2:12) and greater. Use fast cure base coat to promote adhesion to foam. Use standard cure type for finish coat where granules are added, otherwise use fast cure for finish coat. Typical fast cure in 10-20 minutes. Standard cure in 2-8 hours. Available in light and medium grays.		
Type CB (Urethane aromatic) Available as one or two component. Generally low permeability but some are considered permeable. Good abrasion resistance, tensile strength, elongation, impact resistance, and low temperature flexibility. High solids content. Darkens and chalks on exposure. Will withstand moderate ponding water. Use as base, intermediate and finish coat system, or as base and intermediate with Type CF finish coat. Standard dry time of 4-6 hours with cure time of 10-24 hours. Fast dry time of 1-20 minutes with cure time of 10-24 hours. Type CF(Urethane aliphatic) Available as one or two component. Generally low permeability but some are considered permeable. Excellent abrasion resistance, tensile strength, elasticity, impact resistance, and low temperature flexibility. Moderate solids content. Good color and gloss retention. Will withstand moderate ponding water. Use only as finish coat over Type CB base and intermediate coats. Recommended where highly weather resistant or aesthetic finish coat required.		

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SELECTION GUIDANCE TABLE		
COATING DESCRIPTION	PERFORMANCE FEATURES	RECOMMENDED APPLICATIONS
Type A (silicone)	One component system. High permeability (breathable). Good weatherability. Withstands temperature extremes well.	Use on slopes 1:24 (1/2:12)and greater. Typical 4-8 hour cure time. Use dark base coat. Available in off white, tan shades of gray.

SELECTION GUIDANCE TABLE		
COATING DESCRIPTION	PERFORMANCE FEATURES	RECOMMENDED APPLICATIONS
Type B (silicone)	Two component system. High permeability (breathable).	Use on slopes 1:24 (1/2:12) and greater. Use fast cure base coat to promote adhesion to foam. Use standard cure type for finish coat where granules are added, otherwise use fast cure for finish coat. Typical fast cure in 10-20 minutes. Standard cure in 2-8 hours. Available in light and medium grays.
Type CB (Urethane aromatic)	Available as one or two component. Generally low permeability but some are considered permeable. Good abrasion resistance, tensile strength, elongation, impact resistance, and low temperature flexibility. High solids content. Darkens and chalks on exposure.	Will withstand moderate ponding water. Use as base, intermediate and finish coat system, or as base and intermediate with Type CF finish coat. Standard dry time of 4-6 hours with cure time of 10-24 hours. Fast dry time of 1-20 minutes with cure time of 10-24 hours.
Type CF (Urethane aliphatic)	Available as one or two component. Generally low permeability but some are considered permeable. Excellent abrasion resistance, tensile strength, elasticity impact resistance, and low temperature flexibility. Moderate solids content. Good color and gloss retention.	Will withstand moderate ponding water. Use only as finish coat over type CB base and intermediate coats. Recommended where highly weather resistant or aesthetic finish coat required.

Provide protective coating as approved by the foam manufacturer for use as the coating component of a sprayed polyurethane foam roof system. Provide coating consisting of separately applied base, intermediate and finish coat of[one-component silicone (Type A),][two-component silicone (Type B),][two-component urethane-aromatic (Type CB),][or][combination system of two-component urethane-aromatic with two-component urethane-aliphatic finish coat (Type CB and Type CF)]. Coating must bond to urethane foam and have the following minimum properties:

[2.3.1 Type A Coating

Silicone rubber, single component. Provide uncured silicone rubber having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	60, minimum	percent by volume
Solids Content	ASTM D2697	70, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	38, minimum	degrees C

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	60, minimum	percent by volume
Solids Content	ASTM D2697	70, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	100, minimum	degrees F

Provide cured silicone rubber having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 24 degrees C, 50 percent relative humidity	150, minimum	percentage
Tensile Strength	ASTM D412, die C, 24 degrees C, 50 percent relative humidity	2900, minimum	kPa

Properties in Metric Units			
Properties	ASTM Test	Value	Units
UV Exposure	ASTM D822, 6000 hours in atlas carbon arc, Type E weatherometer	No cracking checking, or significant discoloration	---
Hardness, Shore A	ASTM D2240	45, minimum	points
Permeability	ASTM E96/E96M Procedure E 0.50 mm thickness	2.3, maximum	perms

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 75 degrees F, 50 percent relative humidity	150, minimum	percentage
Tensile Strength	ASTM D412, die C, 75 degrees F, 50 percent relative humidity	450, minimum	psi
UV Exposure	ASTM D822, 6000 hours in atlas carbon arc, Type E weatherometer	No cracking checking, or significant discoloration	---
Hardness, Shore A	ASTM D2240	45, minimum	points

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Permeability	ASTM E96/E96M Procedure E 20 mil thickness	2.3, maximum	perms

][2.3.2 Type B Coating

Silicone rubber, two component, with [standard][fast] curing time for [all coats][base coat] [and][standard][fast] cure for intermediate and finish coat. Provide uncured silicone rubber having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	65, minimum	percent by volume
Solids Content	ASTM D2697	75, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	38, minimum	degrees C
Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	65, minimum	percent by volue
Solids Content	ASTM D2697	75, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	100, minimum	degrees F

Provide cured silicone rubber having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 24 degrees C, 50 degrees relative humidity	100, minimum	percentage

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Tensile Strength	ASTM D412, die C, 24 degrees C, 50 degrees relative humidity	3447, minimum	kPa
Permanent Set	ASTM D412	1.0, minimum	percentage
Change in Elongation, Tensile Strength, Permanent Set after Heat Aging 26 weeks at 65 degrees C	ASTM D412	1.0 within tolerance of test	percentage
UV Exposure	ASTM D822, 6000 hours in atlas xenon or carbon arc weatherometer	No cracking, checking or significant discoloration	---
Water Absorption, 168 hours, 24 degrees C	ASTM D570	0.5, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	45, minimum	points
Permeability	ASTM E96/E96M Procedure E 0.50 mm thickness	2.3, maximum	perms

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 75 degrees F, 50 degrees relative humidity	100, minimum	percentage
Tensile Strength	ASTM D412, die C, 75 degrees F, 50 degrees relative humidity	500, minimum	psi
Permanent Set	ASTM D412	1.0, minimum	percentage

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Change in Elongation, Tensile Strength, Permanent Set after Heat Aging 26 weeks at 150 degrees F	ASTM D412	1.0 within tolerance of test	percentage
UV Exposure	ASTM D822,6000 hours in atlas carbon arc, Type E weatherometer	No cracking, checking or significant discoloration	---
Water Absorption, 168 hours, 75 degrees F	ASTM D570	0.5, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	45, minimum	points
Permeability	ASTM E96/E96M Procedure E 20 mil thickness	2.3, maximum	perms

][2.3.3 Type CB Coating

Aromatic urethane elastomer, [one][two] component. Provide uncured urethane having the following values when tested for specified properties in accordance with specified test method:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	73, minimum	percent by volume
Solids Content	ASTM D2697	81, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	28, minimum	degrees C
Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	73, minimum	percent by volue
Solids Content	ASTM D2697	81, minimum	percent by weight

Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Flash Point	ASTM D56 or ASTM D93	82, minimum	degrees F

Provide cured aromatic urethane elastomer having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 24 degrees C, 50 degrees relative humidity	400, minimum	percentage
Tensile Strength	ASTM D412, die C, 24 degrees C, 50 degrees relative humidity	6895, minimum	kPa
Permanent Set at break	ASTM D412	25	percentage
Change in Elongation, Tensile Strength, Permanent Set after Heat Aging 26 weeks at 65 degrees C	ASTM D412	1.0 within tolerance of test	percentage
Tear Resistance	ASTM D624, Die C	26.25 minimum	KN per meter
UV Exposure	ASTM D822, ASTM G155, ASTM G154, 6000 hours in atlas xenon or carbon arc weatherometer, or QUV	No cracking, checking, loss of flexibility or significant discoloration	---
Water Absorption, 168 hours, 24 degrees C	ASTM D570	2.0, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	60, minimum	points

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Permeability	ASTM E96/E96M Procedure E 0.50 mm thickness	1.0, maximum	perms
Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 75 degrees F, 50 degrees relative humidity	400, minimum	percentage
Tensile Strength	ASTM D412, die C, 75 degrees F, 50 degrees relative humidity	1000, minimum	psi
Permanent Set at break	ASTM D412	25, minimum	percentage
Change in Elongation, Tensile Strength, Permanent Set after Heat Aging 26 weeks at 65 degrees C	ASTM D412	1.0 within tolerance of test	percentage
Tear Resistance	ASTM D624, Die C	150, minimum	Pounds per linear inch
UV Exposure	ASTM D822, ASTM G155, ASTM G154, 6000 hours in atlas xenon or carbon arc weatherometer, or QUV	No cracking, checking, loss of flexibility or significant discoloration	---
Water Absorption, 168 hours, 75 degrees F	ASTM D570	2.0, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	60, minimum	points
Permeability	ASTM E96/E96M Procedure E 20 mils thickness	1.0, maximum	perms

][2.3.4 Type CF Coating

Provide aliphatic urethane elastomer, [one][two] component, cured elastomer having no urethane groups bonded directly to aromatic rings. Provide uncured urethane having the following values when tested for specified properties in accordance with specified test methods:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	55, minimum	percent by volume
Solids Content	ASTM D2697	69, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	22, minimum	degrees C
Properties in Inch-Pound Units			
Properties	ASTM Test	Value	Units
Solids Content	ASTM D2697	55, minimum	percent by volue
Solids Content	ASTM D2697	69, minimum	percent by weight
Flash Point	ASTM D56 or ASTM D93	71, minimum	degrees F

Provide cured aliphatic urethane elastomer having the following values when tested for specified properties in accordance with specified test method:

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 24 degrees C, 50 degrees relative humidity	150, minimum	percentage
Tensile Strength	ASTM D412, die C, 24 degrees C, 50 degrees relative humidity	11030, minimum	kPa
Permanent Set at break	ASTM D412	15	percentage
Tear Resistance	ASTM D624, Die C	34.13 minimum	KN per meter

Properties in Metric Units			
Properties	ASTM Test	Value	Units
UV Exposure	ASTM D822, ASTM G155, ASTM G154, 6000 hours in atlas xenon or carbon arc weatherometer, or QUV	No cracking, checking, loss of flexibility or significant discoloration	---
Water Absorption, 168 hours, 24 degrees C	ASTM D570	2.0, maximum	percentage by weight
Hardness, Shore A	ASTM D2240	60, minimum	points
Permeability	ASTM E96/E96M Procedure E 0.50 mm thickness	1.0, maximum	perms

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Elongation	ASTM D412, 75 degrees F, 50 degrees relative humidity	400, minimum	percentage
Tensile Strength	ASTM D412, die C, 75 degrees F, 50 degrees relative humidity	1000, minimum	psi
Permanent Set at break	ASTM D412	25, minimum	percentage
Tear Resistance	ASTM D624, Die C	150, minimum	Pounds per linear inch
UV Exposure	ASTM D822, ASTM G155, ASTM G154, 6000 hours in atlas xenon or carbon arc weatherometer, or QUV	No cracking, checking, loss of flexibility or significant discoloration	---
Water Absorption, 168 hours, 75 degrees F	ASTM D570	2.0, maximum	percentage by weight

Properties in Metric Units			
Properties	ASTM Test	Value	Units
Hardness, Shore A	ASTM D2240	60, minimum	points
Permeability	ASTM E96/E96M Procedure E 20 mil thickness	1.0, maximum	perms

]2.3.5 Energy [and Cool] Roof Performance

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NOTE: Standards such as UFC 1-200-02 promote the use of cool roofing, and increased energy conservation through additional insulation. Design cool roofs following 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. Poor 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.
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NOTE: Design cool roofs following the requirements in UFC 3-110-03 Roofing, Appendix B, and ASHRAE 90.1 Chapter 5, for the design of insulation and energy performance of the building. Design insulation for cool roofs in accordance with the minimum requirements of ASHRAE 90.1 Chapter 5 zone requirements. Inadequate design of cool roofs in ASHRAE climate zones 4 and higher have resulted in unintended consequences of condensation below the membrane, overheating of masonry walls, interior spaces, roof top piping and mechanical equipment as a result of the reflected UV rays.
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NOTE: If a cool roof is selected, meet the ASHRAE 90.1 Chapter 5 values for cool roofing. The roofing system will need to include a top surface layer (e.g. protective coating or surface) that meets Energy Star criteria for Cool Roof Products; see http://energy.gov/eere/femp/covered-product-category-cool-roof-products.

If a cool roof is not selected in zones 1-3, 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. 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.]]

[2.3.6 Energy Star

****
NOTE: Top protective coatings or additional coatings can also provide Energy Star classification as a 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 protective or top coating product that is also 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 protective or additional top coat will not modify or void the required roof warranty.

]2.3.7 Coating Color

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NOTE: Select or insert required color for finish coat. Delete remaining options.
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Provide coating layers of distinguishably different color such that dry film thickness of each layer of the completed application can be determined. Provide finish coat as [white][off-white][light gray][gray][_____].

2.4 PRIMER

Provide primers as required and recommended by the coating and spray foam materials manufacturer for the substrate to be covered. Provide rust-inhibiting primer on ferrous metal surfaces. Cut-back asphalt primers are prohibited.

[2.5 CERAMIC GRANULES

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NOTE: Mineral granules may be embedded in wet

finish coat of silicone coatings. Mineral granule surfacing is generally not required with urethane coating but can be used if desired. Granules are used to:

1. Improve impact resistance to foot traffic, dropped tools, bird pecking, and other impacts;

2. Improve fire resistance;

3. Improve appearance.

****

Provide aggregate surfacing of siliceous mineral granules, 98 percent passing the No. 10 sieve and 98 percent retained on the No. 35 sieve. Provide granules that are free of fines and dust. Provide one-color granule surfacing with the granule color compatible with the color of the topcoat. The color of granules will be selected by the Contracting Officer from the manufacturer's samples and descriptive literature.

]2.6 SEALANTS

Provide sealants as recommended by the coating manufacturer.

[2.7 WALKPADS

Breathable material as recommended by the roof system manufacturer, minimum 1.0 m by 1.2 m 3 ft by 4 ft.

]2.8 TRAFFIC AREA FABRIC

Provide traffic fabric that complies with ASTM D579/D579M, style 1620[, or non-woven polyester as approved by the roof material manufacturer].

2.9 INSPECTION TOOLS

Maintain the following inspection tools on site for use in evaluating conditions and quality:

a. Moisture meter - to measure degree of moisture within or on the substrate surface.

b. Sling Psychrometer and psychrometric chart, or electronic psychrometer or hygrometer - to measure ambient temperature, humidity and dew point.

c. Surface thermometer - to read temperature of a surface.

d. Optical comparator - to read dry film thickness.

e. Magnifying glass, minimum 75 mm 3 inch - to inspect surface conditions.

f. Wet film thickness gauge - read wet film thickness.

g. Probe wire (0.025 inches diameter, maximum) - to inspect foam depth.

PART 3 EXECUTION

3.1 PROTECTION OF PROPERTY

Protect the building structure, equipment, and other surfaces adjacent to the work from overspray from foam and coating materials. Provide protective coverings secured and vented to prevent collection of moisture on covered surfaces. Use protective shields or barriers when spraying along open roof edges and walls to prevent uncontrolled overspray. Restore or replace any surfaces damaged by roof system products to the satisfaction of the Government at no additional expense to the Government.

3.1.1 Masking

Provide masking protection to protect surfaces immediately adjacent to foam and coating terminations at time of application. Adjust or provide new masking protection at roof perimeter to protect surfaces immediately adjacent to coating terminations and to provide for clean smooth coating termination lines.

[3.1.2 Warning Signs

Post warning signs at ground level in the adjacent to the work area and a minimum of 45.72 meters 150 feet from the application area stating the area is off limits to unauthorized persons and warning of potential overspray hazard. Place clearly visible and legible warning sign at entrance to primary road leading to the project facility warning of presence of flammable materials, irritating fumes, and potential of overspray damage.

]3.2 SPECIAL PRECAUTIONS AND INSTRUCTIONS

3.2.1 Safe Working Load Limits

Do not place materials or equipment on the roof deck exceeding the indicated live load limits of the roof construction.

3.2.2 Primers

Do not dilute primers or other materials unless required and recommended by the manufacturer. Do not use cleaning solvents for thinning primers or other materials.

3.2.3 Material Handling

Handle materials and containers during application work safely and in accordance with recommendations of the manufacturer. Store liquids in airtight containers and keep containers closed except when removing materials. Do not use equipment or containers containing remains of dissimilar materials or products. Do not install items that show visual evidence of biological growth.

3.2.4 Shoes

Wear clean, soft-soled shoes without heels while walking on roofing surfaces during installation.

3.2.5 Fire and Explosion Hazards

Prohibit open flames, sparks, welding, and smoking in the application area. Provide and maintain a fire extinguisher of appropriate type and size in the application area.

3.3 ROOF AREA PREPARATION

3.3.1 Preapplication Inspection

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NOTE: Provide expansion joints in the roofing at each expansion joint in the structure, where substrate material changes, and at each intersection where an L- or T-shaped roof deck changes direction. Locate expansion joints at high points, where practicable, and place on curbs above the water line.

NOTE: Clamping rings on in-roof drain receivers are not required and should not be used with spray foam roofing systems.

NOTE: Equipment should be mounted on curbs integrally sealed with the roof system. Curbs should be minimum of one foot high. If possible, complete foam and elastomeric weather coating prior to mounting equipment. Equipment mounted over roof should have not less than 24 inches of clearance between bottom of equipment and roof surface.

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Ensure that [curbs,] [roof penetrations,] [drains,] [equipment supports,] [cants,] [control joints,] [expansion joints,] [perimeter walls,] and perimeter foam stops are in place prior to the application of the [primer and] spray polyurethane foam.

3.3.1.1 Surface Examination

Examine surfaces and correct defects that may adversely affect the roofing system application or performance.

3.3.2 Close Intake Vents

****

NOTE: Specify whether ventilation shutdown will be required during the roof system application. Reroofing projects require closer attention to this issue. Delete "shutdown" if job is new construction and the ventilation system is not being used. Shutdown of the ventilation equipment is necessary to avoid drawing fumes into interior spaces. Where loss of air conditioned rooms is critical, specify portable ventilation and air conditioning units.

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Seal off [and shutdown] air intake vents during foam and coating application. Coordinate with the Contracting Officer. [Give the Contracting Officer 7 days notice before shutting down ventilation equipment.] [Provide portable ventilation and air conditioning during

shutdown [as required by the Contracting Officer][to Room [_____].]]

3.4 GENERAL APPLICATION

Install applications as specified and in general accord with requirements and recommendations of ASTM D5469/D5469M and NRCA RoofMan "Quality Control Guidelines in the Application of Spray Polyurethane Foam Roofing".

3.5 SURFACE PREPARATION FOR FOAM APPLICATION

Verify surfaces that are to be primed or receive spray foam application are dry; completely cured; free of grease, oils, dirt and other foreign matter or contaminants which will interfere with total adhesion of primer and polyurethane foam. Prior to foam application, fill or otherwise seal openings where foam spray may damage or contaminate interior items or surfaces.

[3.5.1 Ferrous Metal

Sandblast iron and steel surfaces which are not primed, shop painted, or otherwise protected in accordance with SSPC SP 6/NACE No.3. Remove loose rust and unsound primer from shop-primed iron and steel surfaces by scraping or wire brushing.

][3.5.2 Concrete Decks

Remove spalling and loose material from the concrete deck and prime, if required, in accordance with recommendations of the manufacturer of the spray polyurethane foam materials.

][3.5.3 Wood Decks and Other Wood Surfaces

****

NOTE: Spray foam may be applied to wood decks when the following minimum requirements are met: Wood decks are designed and constructed for maximum deflection of L/240 under all loading conditions, including dead and live loads and loads from construction or maintenance; all laminated woods have waterproof adhesives; all plywood is at least equal to PS-1, Exterior grade B-C, 13 mm 1/2 inch thick, with edge joints supported by framing. Foam used on wood roofs should not be placed over plank-type or tongue-and-groove wood decks unless decks are first overlaid with 6mm 1/4 inch Exterior grade B-C plywood and nailed on 12 inch centers with 4d, annular-groove nails.

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Prime untreated and unpainted surfaces. If painted, inspect surfaces for adhesion problems.

][3.5.4 Existing Roof Covering Surfaces

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NOTE: This specification is written for new construction; adaptation of this system to reroofing jobs requires preparation of the existing roof in accordance with the spray foam roof manufacturer's

recommendations. Requirements vary based on existing roof type. Where gravel, aggregate or ballasted roof is present, surfacing must be removed prior to spray foam application.
****

Prepare existing roof covering systems to receive spray polyurethane foam in accordance with recommendations of manufacturer of the spray polyurethane foam materials.

]3.6 SPRAY FOAM APPLICATION

3.6.1 Spray Foam

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NOTE: Specify minimum thickness. This thickness is that required to attain the U-factor for the complete roof construction including insulation requirements for the design of heating and air-conditioning systems, except that not less than 38 mm 1-1/2 inch thickness must be specified.
****

Apply foam to provide a minimum finished thickness of[38 mm 1-1/2 inches][_____] inches in at least two spray passes. Apply each spray pass at right angles to the previous pass to the extent practicable. Each pass, except for filleting or tapering as required at terminations, must be between 13 mm 1/2 inch and 25 mm 1 inch in thickness. Check foam thickness during application by probing depth with probe wire. Adjust application procedures as necessary to develop required foam thickness.

3.6.2 Terminations

Unless otherwise indicated, conform with manufacturer's standard details, for foam thickness around drains, penetrations, curbs, and other terminations. Install transitions between horizontal and vertical surfaces as smooth and sprayed at a nominal angle of 45 degrees. Terminate foam uniformly a minimum of 100 mm 4 inches above the roof line at all curb, stack, pipe and other vertical penetrations and boundary terminations in the roof, unless otherwise indicated or required by the roof system manufacturer and approved by the Contracting Officer. At metal eave and rake terminations provide V-cut 13 mm 1/2 inch deep into the foam and fill with sealant compatible with the coating system prior to application of the coating.

3.6.3 Surface Uniformity

Do not exceed the minimum thickness of the foam by more than 13 mm 1/2 inch, except as necessary at transitions and penetrations, or as otherwise approved by the Contracting Officer. Apply the foam of a sufficient overall surface uniformity to prevent water ponding. Using the finished spray foam surface, provide free drainage of the roof area.

3.6.4 Finish Appearance and Texture

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NOTE: Surface Texture: Spray foam tends to telegraph surface over which it is applied. Therefore, some broadcasting of deck joints, lines,

offsets, and other irregularities may appear in finished foam surface unless specified otherwise. Where a smooth, even plane is required, specify as such and insert requirements for filling of with a base layer of foam or leveling of base layer of foam by shaving or scarfing prior to primary foam layers application.
****

Provide the finished surface of applied foam as[a smooth, even plane] free of ridges, bumps, pinholes, depressions, crevices, voids, or oxidation. Provide a surface that is "course orange peel" or smoother in conformance with photographic standards of ASTM D5469/D5469M or SPFA AY-104. Remove and replace any spongy, delaminating, brittle, or otherwise non-complying areas of foam.

3.6.5 Foam Finish Correction

If the sprayed foam skin is removed to correct surface texture or to remove excess foam thickness, respray the cut surface with foam formation at least 13 mm 1/2 inch thick to provide a protective foam skin prior to application of the protective coating.

3.6.6 Finish Removal

Remove foam that is not bonded, of poor cell structure, wet, or otherwise does not meet the material quality specifications.

3.6.7 Application Time Limits

Do not start foam application on an area larger than can be brought to the specified full foam thickness, cured, and coated with the base coat of the coating system on the same day. Allow no applied foam, except for leading edges, to stand uncoated overnight. Inspect the leading edge of foam before resuming work the next day. Remove and replace damaged or wet foam material.

3.6.8 Curing Time

Cure the applied foam for a minimum of 2 hours and as otherwise recommended by the foam manufacturer prior to application of the protective coating.

3.6.9 Spray Foam Clean Up

Remove overspray masking materials and coverings upon completion of the spray foam application and prior to the application of the protective coating. Do not remove the masking over air intake vents until two hours after application of the foam. Remove foam overspray found on adjacent surfaces not scheduled to application of the protective coating.

3.7 SURFACE PREPARATION FOR PROTECTIVE COATING APPLICATION

Apply roof coating on surfaces free of water, grease, oils, dirt, debris, and other foreign materials, and cured completely.

3.7.1 [Metal] [Concrete] [and] [Masonry] Surfaces

[Clean rust and scale from metal surfaces which are to receive roof

coatings by abrasive cleaning or wire brushing. Wipe with an industrial solvent such as naphtha or mineral spirits.] [Wire brush [concrete] [and] [masonry] surfaces which are to receive roof coatings, and remove resulting dust.]

3.7.2 Primer

Apply as recommended by the coating manufacturer.

3.7.3 Sealant

Apply as recommended by the coating manufacturer to include application in V-groove at eave and rake terminations.

3.8 PROTECTIVE COATING APPLICATION

Apply protective coating on foam insulation not less than 2 hours after but on the same day as installation of the foam insulation. Do not leave foam uncoated overnight. Apply coating on insulation, and continue up walls and roof penetrations to a point indicated, but not less than 50 mm 2 inches beyond foam termination where conditions will allow. Provide terminal edges of the foam at roof penetrations, terminations, and roof edges with an extra base coat back 100 mm 4 inches from the edge of the foam and onto adjacent substrate surface. Check roof coating wet film thickness during application to ensure that the wet mil thickness required for each coat is provided. For each coat, provide a dry film thickness not less than specified in paragraph entitled "Minimum Dry Film Thickness (DFT) in Mils." Provide smooth coatings free of runs, dry spray, or overspray, and provide a uniform film over the foam. Consider that coating applications can result in possible coverage loss due to overspray, waste, foam texture, wind, and other factors that affect coverage rate. Adjust methods and quantities to provide the minimum DFT for each coating layer free of blowholes, pinholes, voids, blisters, and other conditions detrimental to coating performance.

3.8.1 Base Coat Application

Apply Type [A] [B] [CB] coating as the base coat. Apply in accordance with manufacturer's printed installation instructions in a manner and rate to provide full coverage at the specified DFT. Apply coating uniformly and in one direction. Inspect the completed surface for blowholes, pinholes, cracks, breaks, voids, blisters, and other defects and repair with base coat material. Allow base coat to cure as recommended by the coating manufacturer prior to application of intermediate coat, but in no case allow the base coat cure time to be less than 2 hours. Check cured base coat to determine dry film thickness before applying the next coat. Clean areas of base coat which become dirty with a clean wet cloth prior to application of intermediate coat.

3.8.2 Intermediate Coat Application

Apply Type [A] [B] [CB] coating in same manner as base coat except apply in a direction perpendicular to the direction in which base coat was applied. Apply intermediate coat within 48 hours of base coat application. Apply in accordance with manufacturer's printed installation instructions in a manner and rate to provide full coverage at the specified DFT. Allow intermediate coat to cure as recommended by the coating manufacturer prior to application of finish coat, but in no case allow the base coat cure time to be less than 2 hours. Check cured

intermediate coat to determine dry film thickness and inspect surface for blowholes, pinholes, cracks, breaks, voids, blisters, and other defects. Repair with intermediate coat material before applying finish coat. If base or intermediate coat thickness is deficient, apply additional intermediate coat prior to applying finish coat to bring total dry film thickness up to that required.

3.8.3 Finish Coat Application

Apply Type [A] [B] [CB] [CF] coating as finish coat in accordance with manufacturer's printed installation instructions in a manner and rate to provide full coverage at the specified DFT, exclusive of granules. Apply in a direction perpendicular to the direction in which intermediate coat was applied. Provide finish coat free of blowholes, pinholes, cracks, breaks, voids, blisters, and other defects that may affect performance, durability, and longevity of the coating.

3.8.4 Minimum Dry Film Thickness (DFT)

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NOTE: When Type CB and CF coating is used in hot and humid climates, specify a total minimum DFT of 1 mm 40 mils with a minimum base and finish coat thickness of 38 mm 15 mils each.
****

Type	Base Coat	Intermediate Coat	Finish Coat	Total System
[A-Silicone]	[0.25 mm]	[0.13 mm]	[0.25 mm]	[0.64 mm]
[B-Silicone]	[0.25 mm]	[0.13 mm]	[0.25 mm]	[0.64 mm]
[CB-Urethane]	[0.25 mm]	[0.13 mm]	[0.25 mm]	[0.75 mm]
[CF-Urethane]			[0.25][0.38] mm	[[0.75][0.88] mm]

Type	Base Coat	Intermediate Coat	Finish Coat	Total System
[A-Silicone]	[10 mils]	[5 mils]	[10 mils]	[25 mils]
[B-Silicone]	[10 mils]	[5 mils]	[10 mils]	[25 mils]
[CB-Urethane]	[10 mils]	[10 mils]	[10 mils]	[30 mils]
[CF-Urethane]			[10][15] mils	[[30][35] mils]

3.8.5 Granule Surfacing

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NOTE: Mineral granules may be embedded in wet

finish coat of silicone coatings. Mineral granule surfacing is generally not required with urethane coating but can be used if desired. Granules are used to:

1. Improve impact resistance to foot traffic, dropped tools, bird pecking, and other impacts;

2. Improve fire resistance;

3. Improve appearance.

****

Spray-apply mineral granules to finish coat, coating within 2 to 5 minutes after application of finish coating, depending on temperature and humidity, as required by roof coating manufacturer's printed installation instructions. Apply using a sand blaster with output pressure reduced to 69 to 138 kPa 10 to 20 psi. Apply granules to surface evenly at a rate of 25 kg per 10 square meters 50 pounds per 100 square feet.[Provide granules in full coverage of the roof surface.][Cover bare spots by applying additional finish coat and granules.] Do not allow traffic on finished areas for minimum 24 hours after granule application is completed.

3.8.6 Penetrations

Apply an additional 0.25 mm 10 mil finish coat for one meter 3 feet all around roof access locations and 0.75 meters 2 feet around all penetrations. Double the specified coating system thickness at all drain sumps, applied in maximum 0.38 mm 15 mil thickness per coat.

3.8.7 Walkways

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NOTE: Walkways should be specified whenever heavy foot traffic on the roof is expected.

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Provide reinforced[walkways][walkpads] where indicated. Provide traffic paths consisting of[additional application of finish coat and granules over first layer of granules and finish coat][a layer of reinforcing fabric laid smooth into and fully overcoated with an additional finish coat to extend minimum 150 mm 6 inches beyond edges of fabric.].

3.8.8 Coating Application Clean-Up

Clean surfaces that receive roof coating materials which are not designated to receive such materials. Remove overspray masking materials and coverings upon completion of the coating work.

3.9 FIELD QUALITY CONTROL

3.9.1 Construction Monitoring

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

a. Protection measures are in place.

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

c. Materials are not installed in adverse weather.

d. Surfaces are cleaned and primed and substrates are in acceptable condition prior to application of materials.

e. Materials comply with specified requirements.

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

g. Foam material is applied in minimum of two passes, or lifts, applied perpendicular to the subsequent pass and in thickness from 13 mm 1/2 inch to 38 mm 1-1/2 inches per lift.

h. Foam is free of blistering in its formation and the surface texture is as specified.

i. Foam is applied to provide for positive drainage of the roof area.

j. Foam is cured minimum of 2 hours and in accordance with manufacturer requirements prior to coating application.

k. Base coat is applied to fully cover the applied foam at the end of each work day.

l. Coating is applied in a minimum of three coats as specified. Each coat is applied perpendicular in direction to the preceeding coat.

m. Wind screens are utilized as necessary.

n. Foot traffic is prohibited on foamed and coated surfaces until completely cured.

o. Granules, where utilized, are embedded as specified.

3.9.2 Coating Wet Film Thickness Monitoring

Prior to application of base coat, place one 100 mm 4 inch square flat metal test plate on surface of foam insulation for every 10 square meters 100 square feet to measure wet film thickness of coating during application. During application of intermediate and finish coats, place plates on surface of previously applied coat in same manner.

3.9.3 Slit samples

Inspect top-coated foam by cutting a minimum of one V-shaped 50 mm 2 inch long by 6 mm 1/4 inch deep sample for every 100 square meters 1000 square feet of roof area as selected at random by the Contracting Officer. Provide one edge of the V-shaped sample at a 90 degree angle to the coated surface. Examine and measure coating thickness of each sample with an optical comparator. Inspect samples at peaks of surface texture of foam, not at valleys. Do not average measurements of DFT of coating. Report slit sample observations in the daily log and provide slit samples to the Government as a part of the daily log. Bag slit samples and identify by sequentially numbering, dating, and locating on roof plan. Completely seal cut areas by filling them with and lapping over adjacent undisturbed coating with caulking material recommended by the coating manufacturer.

Recoat areas where representative samples indicate inadequate thickness and sample again until specified DFT is achieved.

3.9.4 Core samples

Remove minimum of one, 50 mm 2 inch diameter or 50 mm 2 inch square core sample from each day's foam application as directed by the Contracting Officer. Visually examine core samples for proper foam thickness, lift thickness, cell formation and adhesion. Verify foam is free of blisters, voids, and delaminations, and displays full cell formation without spongy nature or brittleness. Identify core samples by sequentially numbering, dating, and locating on roof plan. Report core sample observations on daily log. Maintain core samples at the job site throughout the work for observation by Government personnel. Provide core samples to the Government at completion of the work. Provide additional core samples as directed by the Contracting Officer for laboratory testing to verify conditions and material properties, including compressive strength, density, and cell structure by test methods outlined in ASTM D5469/D5469M. Provide only one core for each day's application unless deficiencies are found that require further testing to determine extent of such deficiency. Provide independent laboratory testing from an independent laboratory approved by the Contracting Officer and at no additional cost to the Government. The Government maintains the right to conduct laboratory testing of core samples for confirmation of conditions. Repair all core locations to a watertight condition with spray applied foam or foam plug set in compatible sealant. Apply protective coating in the specified manner to the repaired area.

[3.9.5 Manufacturer's Field Inspection

Manufacturer's technical representative must visit the site as necessary during the installation process to ensure roof system materials are being applied in a satisfactory manner. As a minimum, manufacturer's technical representative must be present at work start-up and perform field inspection of the first day's completed application and at substantial completion, prior to demobilization of roofing contractor. Conduct inspection in the presence of Government representatives. After each inspection, submit an inspection report signed by the manufacturer's technical representative to the Contracting Officer within 2 working days. Within the inspection report state overall quality of work, deficiencies and any other concerns, and recommended corrective actions in detail. Notify the Contracting Officer a minimum of 2 working days prior to site visit by manufacturer's technical representative.

]3.9.6 Visual Inspection and Moisture Scanning

The Government may conduct a detailed visual inspection and nondestructive moisture scan of the completed installation prior to expiration of the Contractor warranty. The Contractor must repair any roof system deficiencies or remove moisture found in the roof system installation.

3.10 CORRECTION OF DEFICIENCIES

Correct any deficiencies as directed by the Contracting Officer at no additional cost to the Government.

3.11 CLEAN-UP AND DISPOSAL

Clean and remove all waste material, material containers, and debris daily

and placed in appropriate trash containers. At completion of the work, remove all waste material, debris, and containers from the job site and disposed of as required by local regulations.

3.12 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. Provide cards that are 215 mm by 275 mm 8-1/2 by 11 inches minimum. On the information card identify facility name and number; location; contract number; approximate roof area; detailed roof system description, including deck type, identification of foam substrate, foam thickness, type coating, foam and coating manufacturer, date of completion; installing contractor identification and contact information; 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 --