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NAVFAC PTS-B30 (June 2023)  
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Preparing Activity: NAVFAC SUPERSEDING PTS-B30 (September 2022)  
  
PERFORMANCE TECHNICAL SPECIFICATION  
  
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SECTION B30

ROOFING  
06/23

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NOTE: This section is intended to be used as a guide and contains requirements that are common to many different types of facilities. In addition, there may be special requirements for a particular project that are not addressed at all. The RFP preparer will need to incorporate additional information to address these special requirements in this PTS and corresponding Part 3 ESR. If the RFP Preparer chooses to delete building elements that are not required for the project, do not change the remaining Uniformat paragraph designations (example A102001). Uniformat designations are unique to the products they are assigned to. However, the subparagraphs numerical extension (example – 1.2 or a,b,c of the Uniformat designations may change if subparagraphs are deleted).  
  
This guide specification is formatted utilizing Uniformat II, an industry recognized standard, ASTM E 1557. When the RFP preparer chooses to add a paragraph that does not apply to an existing building element already included in the specification, refer to the Uniformat/WBS located on the NAVFAC Design-Build Website for a listing of Uniformat II designations and definitions.  
  
NOTE: The RFP preparer may view or hide the criteria notes in this PTS section by modifying the WORD preferences for "Hidden text". To view the criteria notes, choose "File" then "Option". Click "Display" then check the "Hidden text" box under "Always show these formatting marks on the screen". In the same section, check the box for "Print hidden text" under "Printing options" to print the criteria notes.  
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**B30 GENERAL**

RFP Part 3 including the Engineering System Requirements (ESR) provide project specific requirements. The RFP Part 4, Performance Technical Sections (PTS) provide generalized technical requirements that apply to multiple facility types and include more requirements than are applicable to any one project. Therefore, only the RFP Part 4 requirements that apply to the project and further define the RFP Part 3 project specific requirements are required.

**B30 1.1 DESIGN GUIDANCE**

Provide the design and installation in accordance with the following references. This Performance Technical Specification (PTS) adds clarification to the fundamental requirements contained in the following Government Standards. The general requirements of this PTS section are located in PTS Section Z10, *General Performance Technical Specification*.

Industry standards, codes, and Government standards that are referenced in the section text that are not found in the [Unified Master Reference List (UMRL)](http://www.wbdg.org/ffc/dod/unified-master-reference) in the [Federal Facility Criteria (FFC)](http://www.wbdg.org/ffc/federal-facility-criteria) at the [Whole Building Design Guide (WBDG)](http://www.wbdg.org/) website, are listed below for basic designation identification. Comply with the required and advisory portions of the current edition of the standard at the time of contract award.

**B30 1.1.1 Government Standards**

UNIFIED FACILITIES CRITERIA (UFC)

|  |  |
| --- | --- |
| UFC 1-200-01 | DoD Building Code (A reference in this PTS section to UFC 1-200-01 requires compliance with the Tri-Service Core UFCs that are listed therein, which includes the following significant UFC(s): UFC 3-101-01 Architecture; UFC 3-110-03 Roofing) |
| UFC 1-200-02 | High Performance and Sustainable Building Requirements |

**B30 1.1.2 Design Requirements**

Wind Uplift Resistance: Determine the required wind uplift resistance based on American Society of Civil Engineers (ASCE) ASCE/SEI 7 wind loading calculations or applicable building code requirements and UFC 3-101-01 *Architecture* and UFC 3-110-03 *Roofing*. The specified Factory Mutual (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 allowed and used, delineate calculated values in the roof specification or drawings. Utilize independently tested and rated roof systems, such as Factory Mutual (FM), Underwriters Laboratory (UL), and Single Ply Roofing Industry (SPRI).

The complete roof system assembly must be rated and installed to resist wind loads calculated in accordance with ASCE/SEI 7 and validated by uplift resistance testing in accordance with Factory Mutual (FM) test procedures. Non-rated systems must not be installed, except as approved by the Contracting Officer. Submit licensed engineer's wind uplift calculations and substantiating data to validate any non-rated roof system.

**B30 1.2 PERFORMANCE VERIFICATION AND ACCEPTANCE TESTING**

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NOTE: This paragraph lists tests to be performed by the Contractor as required by the Designer of Record (DOR).  
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Provide verification of satisfactory roofing system performance via Performance Verification Testing, and by field inspection as detailed in this section of the RFP. All performance and acceptance testing including final/warranty inspections must be witnessed by the Contracting Officer on all significant roof projects.

A significant roof is defined as a single or group of buildings with greater than 15,000 square feet (1,400 m2) of roof area; or a roof with area that is allocated to energy generating equipment such as solar hot water panels or photovoltaic panels; or where building equipment (excluding HVAC), use, or safety causes multiple roof penetrations.

**B30 1.2.1 Pre-Roofing Design Conference**

If the project roof meets the definition of a significant roof above, provide a Pre-Roofing Design Conference. Schedule this conference prior to the roof design and roof layout of the facility. Required attendees include the Designer of Record (DOR), Design Quality Control (DQC) Manager, Roof Design Assurance Consultant (if applicable), Commissioning Authority, and Subcontractors directly responsible for installing the roof and equipment that will be mounted on the roof. Discuss and coordinate the following as a minimum:

a. Renewable energy systems to be mounted on the roof and interface with building systems and utilities,

b. Allocation of space on the roof for different functions,

c. Impact of renewable energy systems and building orientation to the suns path,

d. Waterproofing, flashing, and future reroofing considerations of the facility resulting from renewable energy systems inclusion on the roof,

e. Measures taken to eliminate penetration of the roof membrane. National Roofing Contractors Association (NRCA) roof details proposed for each necessary penetration,

f. Structural requirements to support roof mounted equipment,

g. Aesthetic impact of roof mounted equipment on the facility and measures taken to mitigate negative appearances of equipment.

h. Maintenance and Commissioning requirements of the roof and roof mounted equipment to facilitate final testing and provide proper access and roof membrane protection.

**B30 1.2.2 Pre-Roofing Design Conference**

If required in RFP Part 3, the Contractor shall hold a Pre-Roofing Design Conference with the Contracting Officer. Schedule this conference prior to the roof design and roof layout of the facility. Attendee's shall include the DOR, DQC Manager, Roof Design Assurance Consultant (if applicable), Commissioning Authority, and Subcontractors directly responsible for installing the roof and equipment that will be mounted on the roof. Discuss and coordinate the following as a minimum:

a. Sustainable systems to be mounted on the roof and interface with building systems and utilities,

b. Allocation of space on the roof for different functions,

c. Impact of sustainable systems and building orientation to the suns path,

d. Waterproofing, flashing, and future reroofing considerations of the facility resulting from sustainable systems inclusion on the roof,

e. Measures taken to eliminate penetration of the roof membrane. NRCA roof details proposed for each necessary penetration,

f. Structural requirements to support roof mounted equipment,

g. Aesthetic impact of roof mounted equipment on the facility and measures taken to mitigate negative appearances of equipment.

h. Maintenance and Commissioning requirements of the roof and roof mounted equipment to facilitate final testing and provide proper access and roof membrane protection.

**B30 1.2.3 Pre-Roofing Conference**

Prior to beginning roofing work, hold a Pre-Roofing Conference with the Contracting Officer. Required attendees include personnel directly responsible for the roofing systems design and construction, DQC Manager, Commissioning Authority, as well as the roofing manufacturer's technical representative, and Roof Design Consultant (if applicable). At this time the Contractor will address any conflicts between the proposed roofing system, the design documents, and the scheduling of work / workers (trades) to assure a watertight roofing installation. Resolutions will be obtained and documented in writing prior to the start of roofing work. A quality assurance/quality control plan must also be established at this time, inclusive of the roofing manufacturer's recommended testing and inspections procedures, and in accordance with industry standard guidelines.

Contractor must provide the following additional information at the pre-roofing conference: Procedure for the roof manufacturer’s technical representative's onsite inspection and acceptance of the roofing substrate, roof insulation, and installation of the roofing in accordance with the roof system warranty, the name of the manufacturer's technical representatives, the frequency of the onsite visits, copies of the roof status reports from the technical representatives to the roof manufacturer, and pertinent structural details to the roofing system.

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NOTE: If a Roof Design Assurance Consultant is needed, consider using a Registered Roof Observer as a QC specialist in Part 2 Section 01 45 00.05 20, *Design and Construction Quality Control*.  
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**B30 1.2.4 Roof Design Assurance**

If the project roof meets the definition of a significant roof above, the Contractor must utilize the services of a Registered Roof Consultant (RRC) certified by the Roof Consultant Institute, or a Registered Professional Architect or Engineer who specializes in roofing, to approve the roof design. The roof consultant must derive his or her principal income from roofing design on the quality control staff of the Design or Design-Build team. The roof consultant must verify in writing that the design for the project is in accordance with the current edition of NRCA *Roofing and Waterproofing Manual*, UFC 3-110-03, the RFP, and standard industry practices and building codes.

**B30 1.2.5 Low Slope Roof Drain Test**

Plug roof drains and fill with water to the edge of the drain sump for 24 hours. Not all drains will be tested at one time. Measure water at the beginning and end of the 24-hour time period to ensure there is no leakage. Repeat testing until all leaks have been located, corrected, and no leaks found.

**B30 1.2.6 Tests for Surface Dryness**

Prior to application of roofing materials, perform surface dryness tests in presence of DOR. Asphalt of 350 to 400 degrees F (177 to 204 degrees C) must not foam upon contact with substrate. After foaming test is performed, test for strippability (adherence).

**B30 1.2.7 Quality Control Program**

Establish a quality control program to assure adherence to NRCA recommended Quality Control Guidelines for the Application of Roofing Systems and other specified application requirements. Compliance with Part 2 Section 01 45 00, *Quality Control*, is required.

**B30 1.3 DESIGN SUBMITTALS**

Provide design submittals in accordance with PTS Section Z10, *General Performance Technical Specifications*, Part 2 Section 01 33 10.05 20, *Design Submittal Procedures*, Facilities Criteria (FC) 1-300-09N, *Navy and Marine Corps Design Procedures,* UFC 3-101-01, *Architecture* and UFC 3-110-03, *Roofing*.

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NOTE: NAVFAC has made every effort to use commercial standards in the PTS sections. This PTS section is designed to only use commercial standards. If project requirements dictate the use of a UFGS sections as a standard, add a paragraph here listing the required UFGS section. State in the paragraph that the DOR must edit this UFGS section in accordance with PTS Z10 and submit it as a part of the design submittal.  
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**B30 1.4 CONSTRUCTION SUBMITTALS**

Submit construction submittals in accordance with PTS Section Z10, *General Performance Technical Specifications*. In addition to the Z10 requirements, the Designer of Record (DOR) must approve the following submittals as a minimum:

Test reports, color samples, certificates of conformance, warranties, close out documentation, and manufacturer's instructions for application and installation on all products used on the roof. Products used on the roof consist of but are not limited to structural deck, insulation, membrane or panels, Standing Seam Metal Roofing (SSMR), flashing, fasteners, nailers, accessories and equipment support curbs or equipment support stands for solar equipment, equipment roof plan, maintenance access and paths.

**B3010 ROOF COVERINGS**

Roof coverings must comply with the requirements of UFC 3-110-03, *Roofing*, and NRCA, *Roofing and Waterproofing Manual* found at <http://www.nrca.net/rp/technical/manual/manual.aspx> as the primary NAVFAC roofing criteria. Determine wind uplift using wind speed in accordance with ASCE/SEI 7.

Submit the INFORMATION CARD (see "Form 1" at the end of this section) Provide a typewritten card, laminated in plastic and framed in a weather-tight frame, or a photoengraved 0.032-inch (0.81 mm) thick aluminum card for the roof. This card must be a minimum size of 8 1/2 x 11 inch (216 x 280 mm) and contain information listed in the attached Form 1. Install the card where directed. Furnish framed card and a duplicate card to the Designer of Record.

**B301001 STEEP SLOPE ROOF SYSTEMS**

Slope conversions from low slope to steep slope roofing systems must specifically address temporary waterproofing protection where new framing connections penetrate the existing low slope system.

**B301001 1.1 SLATE ROOFING**

Install slate roofing systems in accordance with NRCA Standards.

**B301001 1.1.1 Warranty**

Contractor must supply manufacturer's standard warranty against defects in product workmanship and materials, including related metal flashing for a period of 30 years from the date of FINAL acceptance of the work.

**B301001 1.1.2 Materials**

a. Slate - Slate materials must meet the grading standards of the National Slate Association. Field punching of slate must be from the back of the slate.

b. Underlayment Membrane - For standard slate roofs, roofing felts must be un-perforated asphalt-saturated felts, No. 30 or heavier. For graduated slate roofs, two layers of felts must be applied with joints and laps staggered. When roof slopes are less than 4:12, a double layer of felt must be applied in mastic or hot asphalt must be applied. At the roofing perimeter, eaves, rakes, sidewalls, head walls, valleys and all penetrations, install self-adhering membrane (3 foot band minimum) (900 mm band minimum).

c. Fastening - Nails must be stainless steel or copper ring shank nails. Nails must be long enough to penetrate the roof sheathing with heads of sufficient diameter to prevent pullover of slate. Slate must hang on the shaft of the fastener, and drawn to, but not tight against the slate surface. Exposed nails on the top courses must be sealed. In high wind areas, provide mechanical fastening plus sealant adhesive attachment. Provide screws, wire ties, hook nails, tile locks and storm clips of brass, copper or stainless steel as recommended by the manufacturer for the project.

d. Flashing - Flashings for slate roofing must be 16 oz. (454 g) copper or 24 gage stainless steel, and 16 oz. (454 g) lead-coated copper, and must be protected to prevent the potential for galvanic action by having contact with dissimilar metals.

e. Snow Guards - Provide snow guards of type compatible with roof system specified, and designed to meet design loads for the project location.

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NOTE: Asphalt shingles should only be used for residential construction and light commercial construction where the cost of metal roofing or slate or roof tiles cannot be justified.  
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**B301001 1.2 ASPHALT SHINGLES**

The shingle roofing system shall be installed in accordance with NRCA *Roofing and Waterproofing Manual*(Latest Edition), "Steep Roofing", closed cut valley flashing shall not be allowed and per ASTM D 3462.

**B301001 1.2.1 Warranties**

Furnish to the Government the manufacturer's standard lifetime material warranty for the asphalt shingles. The Contractor must also warrant that the asphalt shingle roofing system, as installed, is free from defects in workmanship. Provide a minimum 10-year fungus resistance warranty in southern climate and areas susceptible to fungus growth on shingles.

**B301001 1.2.2 Materials**

a. Shingles - Shingles must meet ASTM D 3018, Type I, and ASTM D 3462, and must weigh not less than 210 pounds per 100 square feet (95 kg per 9.3 square meters). Shingles must meet the fire resistance requirements of Underwriters Laboratories (UL) 790 for Class 'A' and resist winds in accordance with ASCE/SEI 7 when tested in accordance with UL 997.

b. Shingle Underlayment - Asphalt-saturated felt conforming to ASTM D 226, Type I.

c. Self-Adhering Membrane - Self-adhering rubberized asphaltic membrane, a minimum of 40 mils thick. Provide at all ridges, valleys, sidewalls and starter strips.

d. Nails - 11 or 12 gauge hot-dipped galvanized steel, corrosion resistant roofing nails, with sharp points and flat heads 3/8 inch to 7/16 inch (9.5 mm to 11 mm) diameter. Shank diameter must be a minimum of 0.105 inch (2.7 mm) to a maximum of 0.135 inch (3.4 mm). Nails must be long enough to penetrate through all layers of roofing materials and achieve secure anchorage into a roof deck. A minimum of 4 nails must be used on a full width shingle, and six nails in high wind areas. Location of nails must be as shown in manufacturers printed installation instructions. Staples are not permitted as a means of attachment.

e. Asphalt Roof Cement - ASTM D 4586, Type II

f. Asphalt Primer - ASTM D 41

**B301001 1.3 ROOF TILES**

**B301001 1.3.1 Warranty**

The contractor must warrant for 30 years that the tile roofing system, as installed, is free from defects in workmanship.

**B301001 1.3.2 Materials**

a. Clay Tile - ASTM C 1167, machine-formed natural clay tiles, kiln-fired to vitrification and free from surface imperfections. Provide specially shaped units as required to provide watertight installation and closure. Form fastening holes prior to firing.

b. Concrete Tile - ASTM C 1492, molded or extruded, interlocking concrete roofing tile units, and specially shaped as required to provide a watertight installation and closure. Provide with cast-in anchor lugs, transverse weather checks and fastening holes.

**B301001 1.3.3 Underlayment**

Determine underlayment type by slope as follows:

10:12 slope and above must have a minimum of one layer of number 30 felt, laid in shingle fashion with a minimum of a 2 inch (50 mm) lap.

4:12 to 10:12 slopes must have a minimum of 2 layers of number 30 felt or one layer of a modified bitumen underlayment for use with standard size tile as long as tile is laid with a minimum of a 3 inch (75 mm) headlap. Underlayment must be laid shingle fashion with a 19-inch (480 mm) lap.

Tiles are not permitted to be laid on slopes less than 4:12.

a. Felt Underlayment - Asphalt saturated felt conforming to ASTM D 226, Type I.

b. Flexible Hip, Starter and Ridge Flashing - Provide SBS Modified rubberized asphalt adhesive on a linear, low-density polyethylene membrane with a 60 mil total thickness, or 40 mil thick self-adhered membrane underlayment in accordance with ASTM D 1970. At the roofing perimeter, eaves, rakes, sidewalls, head walls, valleys and all penetrations, install self-adhering membrane (3 foot (900 mm) band minimum).

**B301001 1.3.4 Substrate Panels for Application Over Metal Deck**

a. Glass Mesh Mortar Units - ASTM E 84, exterior type panels of Portland cement.

b. Fiberglass-Faced Gypsum Roof Board - ASTM 1177/C 1177M

**B301001 1.3.5 Fasteners**

a. Nails for Applying Felt Underlayment - Hot dip galvanized steel, 11 gage, of sufficient length to penetrate through substrate panels.

b. Materials for Installation of Tile - Nails must be round-head, sharp point, 11 or 12 gauge, copper or stainless steel ring shank roofing nails. Nail heads must be low profile, smooth and flat. Shanks may be smooth, barbed or otherwise deformed for added pull out resistance. Nails should be of sufficient length to penetrate one inch (25 mm) into wood ridge and hip boards, or battens, with heads of sufficient size to prevent pullover of the tile.   
1) Wind Locks must be of 10 gage copper or brass, 12 gage galvanized steel, or 0.084 inch (2.1 mm) stainless steel formed wire clips.   
  
2) Provide hurricane clips with two nail holes in the horizontal leg for anchorage to deck or substrate.

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NOTE: Where the roof is installed in areas of high winds, over areas of high levels of pedestrian traffic and exposure to extreme freeze-thaw cycles:  
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3) Provide dual means of attachment of tile as follows, or as recommended by the tile manufacturer: Mechanical fastening plus hurricane clips, mechanical fastening plus foam setting, mechanical fastening plus sealant adhesive attachment of tile to tile in headlap areas.

**B301001 1.3.6 Preservative-Treated Lumber - AWPA C1**

**B301001 1.3.7 Sheet Metal Flashing and Trim**

Fabricate sheet metal flashing and trim of 20 oz. Copper, lead-coated copper or stainless steel to comply with SMACNA *Architectural Sheet Metal Manual*.

**B301001 1.3.8 Bird-stop for Concrete Tile**

Provide 20 oz. (567 g) copper, lead or stainless steel "L" section with 3-inch (75 mm) wide horizontal leg and vertical leg cut to conform to bottom profile of tile, or provide mortar formed bird-stops with weep holes, molded plastic bird-stops, or prefabricated tiles as recommended by roofing tile manufacturer.

**B301001 1.3.9 Mortar**

ASTM C 270, Type M mortar mix. Use of mortar set tile is not permitted in high-wind areas.

**B301001 1.3.10 Asphaltic Plastic Cement**

ASTM D 4586.

**B301001 1.3.11 Foam-set Tile**

Provide foam plastic adhesive designed to meet the concrete and clay tile roofing industries requirements for adhering roofing tile to specified roof underlayment assemblies. Foam adhesive must meet ASTM E 84, with a flame spread of less than 75. When tested in accordance with ASTM E 108, the roof covering system must qualify as a Class 'A' roof covering system.

**B301001 1.4 METAL ROOF PANELS (ARCHITECTURAL STANDING SEAM METAL ROOFS ON SUPPORTED SUBSTRATE)**

**B301001 1.4.1 Manufactured Sheet Metal Roofing**

Provide galvanized steel or aluminum-zinc coated steel or aluminum panels formed at the manufacturing plant and conditioned for flatness. Determine panel thickness by the requirements of NRCA, *Roofing and Waterproofing Manual*, but not less than 24 gauge for panels less than 16 inches wide (400 mm), and 22 gauge for panels 16 inches (400 mm) wide or greater. All panels greater than 12 inches (300 mm) wide must have preformed reinforcing ribs or embossed for stiffening. The minimum gauge for aluminum panels must be 20-gauge, .032 inch thick (.8 mm thick) or greater. Roofing design must meet deflection and wind load requirements per building code.

The SSMR system covered under this specification must include the entire roofing system; the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system must consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system.

a. Provide inverted "L" Standing Seam shape roofing panels.

b. Panel Protection - Treat exposed cut edges with compatible coating comparable to the factory applied coating system for corrosion protection.

c. Sealants - Provide non-curing, non-skinning butyl based sealants and tapes for concealed locations such as within laps and under eaves. Provide polyurethane and curing butyl elastomeric sealants for exposed locations such as along top edge of surface mounted counter flashings.

d. Factory Color Finish - Provide factory applied, baked coating to the exterior and interior of metal wall panels and metal accessories. Provide exterior finish top coat of 70 percent polyvinylidene fluoride resin with not less than 0.8 mil dry film thickness. Provide exterior primer standard with panel manufacturer with not less than 0.8 mil dry film thickness. Interior finish must consist of 0.5 mil dry film thick backer coat if permanently concealed from view by construction or the same coating and dry film thickness as the exterior coating if the panel interior side will be exposed. Provide factory-applied clear 70 percent polyvinylidene fluoride (PVF), 0.8 mil top coat and edge coating on all factory-cut or unfinished panel edges for projects within 300 feet (91 meters) of the ocean or industrial environments.

e. Warranty - Furnish manufacturer's no dollar limit materials and workmanship warranty for the roofing system. The warranty period must not be less than 20 years from the date of Government acceptance of the work. The warranty must be issued directly to the Government. The warranty must provide that if within the warranty period the metal roofing system becomes non-watertight or shows evidence of corrosion, perforation, peeling paint, rupture or excess weathering due to deterioration of the roofing system resulting from defective materials or workmanship the repair or replacement of the defective materials and correction of the defective workmanship must be the responsibility of the roofing system manufacturer. Repairs that become necessary because of defective materials and workmanship while roofing is under warranty must be performed within 7 days after notification, unless additional time is approved by the Contracting Officer. Failure to perform repairs within the specified period of time will constitute grounds for having the repairs performed by others and the cost billed to the manufacturer. Provide a 2-year contractor installation warranty. Coating must not show a color change greater than 5 NBS color units in accordance with ASTM D2244, and not show chalking in excess of 10 in accordance with ASTM D4214.

f. Wind Uplift - Metal roofing systems must be designed and attached to resist wind uplift pressures calculated in accordance with ASCE/SEI 7. Uplift resistance must be validated by applicable Factory Mutual (FM), Underwriters Laboratories (UL), or ASTM uplift resistance test procedures.

**B301001 1.4.2 Metal Roof Design Requirements**

Design the SSMR system as a complete system. Roof panels, components, transitions, accessories, and assemblies must be supplied by the same roofing system manufacturer. Provide to the DOR a design analysis signed by a Registered Professional Engineer employed by the SSMR manufacturer. The design analysis must include a list of the design loads, and complete calculations for the roofing system and its components; valley designs, gutter/downspout calculations, screw pullout test results, and indicate how expected thermal movements are accommodated.

**B301001 1.4.3 Accessories**

Provide other sheet metal flashings, trim moldings, closure strips, caps and other preformed metal panel accessories, of the same material, thickness and finish as panels, except accessories that are concealed after installation, and are aluminum or zinc-coated steel may be provided unfinished. Provide molded closure strips of closed-cell or solid-cell synthetic rubber, neoprene, or polyvinyl chloride premolded to match configurations of preformed metal panels. All accessories must be manufactured or approved by the roof panel manufacturer.

**B301001 1.4.4 Fasteners**

Provide concealed fasteners for attaching panels to structural supports and to adjoining panels as approved and in accordance with printed manufacturer's recommendations.

**B301001 1.4.5 Field Quality Control**

Install in accordance with the approved manufacturer's erection instructions, shop drawings, and diagrams. Panels must be in full and firm contact with attachment clips. Where prefinished panels are cut in the field, or where any of the factory applied coverings or coatings are abraded or damaged in handling or installation, they must, after necessary repairs have been made with material of the same color as the weather coating, be approved before being installed. Seal openings through panels. Correct defects or errors in the materials. Replace materials which cannot be corrected in an approved manner with nondefective materials. Provide molded closure strips where necessary to provide weathertight construction. Use shims as required to ensure attachment clip line is true. Use a spacing gage at each row of panels to ensure that panel width is not stretched or shortened. Provide 30-pound layer of asphalt-saturated felt placed perpendicular to roof slope, covered by a slip sheet. Overlap side and end laps 75 mm 3 inches, offset seams in building paper with seams in felt.

Apply roofing panels with the standing seams parallel to the slope of the roof. Provide roofing panels in longest practical lengths from ridge to eaves (top to eaves on shed roofs), with no transverse joints except at the junction of ventilators, curbs, and similar openings. Install flashing to assure positive water drainage away from roof penetrations. Locate panel end laps such that fasteners do not engage supports or otherwise restrain the longitudinal thermal movement of panels. Attach panels to the structure with concealed clips incorporated into panel seams. Clip attachment must allow roof to move independently of the structure, except at fixed points as necessary.

**B301001 1.5 STRUCTURAL METAL ROOFING SYSTEM**

**B301001 1.5.1 Structural Standing Seam Metal Roof (SSSMR) System**

The SSSMR system covered under this specification must include the entire roofing system; the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system must consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system.

**B301001 1.5.2 Design Requirements**

Design the SSSMR system as a complete system, in accordance with ASCE/SEI 7. Provide a design for framing members and connections not indicated on the drawings. Roof panels, components, transitions, accessories, and assemblies must be supplied by the same roofing system manufacturer. Provide to the DOR a design analysis signed by a Registered Professional Engineer employed by the SSSMR manufacturer. The design analysis must include a list of the design loads, and complete calculations for the support system (when provided by the Contractor), roofing system and its components; valley designs, gutter/downspout calculations, screw pullout test results, and indicate how expected thermal movements are accommodated.

a. Dead Loads - The dead load is the weight of the SSSMR system. Collateral loads such as sprinklers, mechanical and electrical systems, and ceilings must not be attached to the panels.

b. Concentrated Loads - The panels and anchor clips must be capable of supporting a 300 pound concentrated load. The concentrated load must be applied at the panel mid-span and will be resisted by a single standing seam metal roof panel assumed to be acting as a beam. Use the un-deformed shape of the panel to determine the section properties.

c. Uniform Loads - The panels and concealed anchor clips must be capable of supporting the minimum uniform live load specified in the project program.

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: Snow load, including unbalanced roof snow loads and drift load will be calculated in accordance with ASCE 7.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

d. Roof Snow Loads - The design roof snow loads must be shown on the contract drawings.

e. Wind Loads - The design wind uplift pressure for the roof system must be shown on the contract drawings. The design uplift force for each connection assembly must be the pressure given for the area under consideration, multiplied by the tributary load area of the connection assembly. The safety factor listed below must be applied to the design force and compared against the ultimate capacity. Prying must be considered when figuring fastener design loads.   
  
1) Single fastener in each connection.............3.0   
  
2) Two or more fasteners in each connection...2.25

f. Framing Members Supporting the SSSMR System - Design of new or revised framing members and their connections must in accordance with American Institute of Steel Construction (AISC) 335, American Iron and Steel Institute (AISI) SG-973, or SJI Specs & Tables. Maximum deflection under applied live load, snow, or wind load must not exceed 1/180 of the span length.

g. Roof Panels Design – Deflections must be based on panels being continuous across three or more supports. Deflection must be calculated and measured along the major ribs of the panels.   
  
1) Design steel panels in accordance with AISI SG-973.   
  
2) Design aluminum panels in accordance with AA ADM. The panel deflection from concentrated loads must not exceed 1/180 of the span length. The panel deflection under applied live load, snow, or wind load shall not exceed 1/180 times the span length.

**B301001 1.5.3 Performance Requirements**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: Testing is required to verify the adequacy of the SSSMR system. External reinforcement of panel seams is not permitted, except when approved by the customer and the designer. Consider the use of closer purlin spacing and narrow width panels (12 inches (305 mm)) in order to eliminate the need for external reinforcement. External reinforcement includes clips, and clamps on the ribs or seams.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

a. Test the SSSMR for wind uplift resistance in accordance with ASTM E 1592; SSSMR systems previously tested and approved may be acceptable.

b. SSSMRS Warranty Certificate -- At the completion of the project furnish signed copies of the 5-year Warranty for Structural Standing Seam Metal Roof (SSSMR) System, a sample copy of which is attached to this section, and the 20-year Manufacturer's Material Warranties, and the manufacturer's 20-year system weather-tightness warranty.   
  
1) Contractor's Weather-tightness Warranty   
  
Warranty the SSSMR system on a no penal sum basis for a period of five years against material and workmanship deficiencies; system deterioration caused by exposure to the elements or inadequate resistance to specified service design loads, water leaks, and wind uplift damage. The SSSMR system covered under this warranty must include the entire roofing system including, but not limited to, the standing seam metal roof panels, fasteners, connectors, roof securement components, and assemblies tested and approved in accordance with ASTM E 1592. In addition, the system must consist of panel finishes, slip sheet, insulation, vapor retarder, all accessories, components, and trim and all connections with roof panels. This includes roof penetration items such as vents, curbs, and skylights; interior or exterior gutters and downspouts; eaves, ridge, hip, valley, rake, gable, wall, or other roof system flashings installed and any other components specified within this contract to provide a weathertight roof system; and items specified in other sections of these specifications that are part of the SSSMR system. Repair all material and workmanship deficiencies, system deterioration caused by exposure to the elements /or inadequate resistance to specified design loads, water leaks and wind uplift damage as approved by the DOR. See the attached Contractor's required warranty for issue resolution of warrantable defects. This warranty must warrant and cover the entire cost of repair or replacement, including all material, labor, and related markups. Supplement this warranty with written warranties from the installer and system manufacturer, and submit them along with Contractor's warranty; however, the Contractor will be ultimately responsible for this warranty   
  
2) Manufacturer's Material Warranties

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: The 20-year system weather tightness warranty, required in paragraph c. below, will increase construction cost, and should be used only after consultation with the customer.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

Furnish, in writing, the following manufacturer's material warranties which cover all SSSMR system components such as roof panels, anchor clips and fasteners, flashing, accessories, and trim, fabricated from coil material:

a) A manufacturer's 20-year material warranty warranting that the aluminum, zinc-coated steel, aluminum-zinc alloy coated steel or aluminum-coated steel as specified herein will not rupture, structurally fail, fracture, deteriorate, or become perforated under normal design atmospheric conditions and service design loads. Liability under this warranty must be limited exclusively to the cost of either repairing or replacing nonconforming, ruptured, perforated, or structurally failed coil material.   
  
b) A manufacturer's 20-year exterior material finish warranty on the factory colored finish warranting that the finish, under normal atmospheric conditions at the site, will not crack, peel, or delaminate; chalk in excess of a numerical rating of eight, as determined by ASTM D 4214 test procedures; or change color in excess of five CIE or Hunter Lab color difference (delta E) units in accordance with ASTM D 2244. Liability under this warranty is exclusively limited to refinishing with an air-drying version of the specified finish or replacing the defective coated material.   
  
c) A roofing system manufacturer's 20 year, non-prorated, system weather tightness warranty.

**B301001 1.5.4 Roof Panels**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: See TI 809-29 for guidance on roof slope and height of seams.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

Panels must be steel or aluminum and have a factory color or mill finish. Length of sheets must be sufficient to cover the entire length of any unbroken roof slope for slope lengths that do not exceed 30 feet. When length of run exceeds 30 feet and panel laps are provided, each sheet in the run must extend over three or more supports. Sheets longer than 100 feet may be furnished if approved by the DOR. Width of sheets must provide not more than 24 inches of coverage in place. SSSMR system with roofing panels greater than 12 inches in width must have standing seams rolled during installation by an electrically driven seaming machine.

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: When a factory color finish is specified, paragraph "2." does not apply. AZ 50 coating is allowed for factory-color-finish and not for mill finish. These two paragraphs do not apply when steel panels are not used in the project.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

a. Steel panels   
  
1) Provide zinc-coated steel panels conforming to ASTM A 653/A 653M; aluminum-zinc alloy coated steel conforming to ASTM A 792/A 792M, AZ 55 or 50 coating; or aluminum-coated steel conforming to ASTM A 463/A 463M,Type 2, coating designation T2 65. Zinc, zinc-aluminum alloy or aluminum coated panels must be 0.023 inch (0.584 mm) thick minimum. Panels must be within 95 percent of reported tested thickness as noted in wind uplift resistance testing required in paragraph "PERFORMANCE REQUIREMENTS".   
  
2) Prior to shipment, if the panels are not specified with a factory color finish, mill finish panels must be treated with a passivating chemical to inhibit the formation of oxide corrosion products. Panels that have become wet during shipment and have started to oxidize will be rejected.  
 **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: This paragraph does not apply when aluminum panels are not used in the project.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

b. Aluminum Panels - Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.032 inch thick.

**B301001 1.5.5 Concealed Anchor Clips**

Concealed anchor clips must be the same as the tested roofing system.

**B301001 1.5.6 Accessories**

Flashing, trim, metal closure strips, caps and similar metal accessories must be the manufacturer's standard products. Exposed metal accessories must be finished to match the panels furnished.

**B301001 1.5.7 Fasteners**

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: Fasteners that are not color coated may be limited to 400-series corrosion resisting steel when justified by atmospheric exposure conditions.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

Fasteners for steel roof panels must be zinc-coated steel, aluminum, corrosion resisting steel, or nylon capped steel, type and size specified below or as otherwise approved for the applicable requirements. Fasteners for aluminum roof panels must be aluminum or corrosion resisting steel. Fasteners for structural connections must provide both tensile and shear ultimate strengths of not less than 750 pounds per fastener. Exposed roof fasteners must be sealed or have sealed washers on the exterior side of the roof to waterproof the fastener penetration. Washer material must be compatible with the roofing; have a minimum diameter of 3/8 inch for structural connections; and gasketed portion of fasteners or washers must be neoprene or other equally durable elastomeric material approximately 1/8 inch thick. Exposed fasteners for factory color finished panels must be factory finished to match the color of the panels.

a. Screws - Screws for attaching anchor devices must not be less than No. 14

b. Bolts - Bolts must not be less than 1/4 inch diameter, shouldered or plain shank as required, with locking washers and nuts.

c. Structural Blind Fasteners - Blind screw-type expandable fasteners must not be less than 1/4 inch diameter. Blind (pop) rivets must not be less than 9/32 inch minimum diameter.

**B301001 1.5.8 Sub-purlins**

Cold formed supporting structural members/sub-purlins must have a minimum thickness of 0.059 inches and a minimum tensile yield strength of 50000 psi. Hot rolled structural members must have a minimum thickness of 0.25 inches and a minimum tensile yield strength of 36000 psi. Sub-purlins must be galvanized or shop painted, as required by the project program.

**B301001 1.5.9 Factory Color Finish**

Panels must have a factory applied polyvinylidene fluoride finish on the exposed side. The exterior finish must consist of a baked-on topcoat with an appropriate prime coat. The exterior coating must be a nominal 2 mil thickness consisting of a topcoat of not less than 0.7 mil dry film thickness and the paint manufacturer's recommended primer of not less than 1.0 mil thickness. The interior color finish must consist of the same coating and dry film thickness as the exterior. The exterior color finish must meet the test requirements specified below.

a. Salt Spray test - A sample of the sheets must withstand a cyclic corrosion test for a minimum of 2016 hours in accordance with ASTM D 5894, including the scribe requirement in the test. Immediately upon removal of the panel from the test, the coating must receive a rating of not less than 10, no blistering, as determined by ASTM D 714; 10, no rusting, as determined by ASTM D 610; and a rating of 6, over 21/16 to 1/8 inch failure at scribe, as determined by ASTM D 1654.

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: The results of the salt spray test will vary depending on the thickness of the coating.  
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b. Formability Test - When subjected to testing in accordance with ASTM D 522 Method B, 1/8 inch diameter mandrel, the coating film must show no evidence of cracking to the naked eye.

c. Humidity Test - When subjected to a humidity cabinet test in accordance with ASTM D 2247 for 1000 hours, a scored panel must show no signs of blistering, cracking, creepage or corrosion.

d. Impact Resistance - Factory-painted sheet must withstand direct and reverse impact in accordance with ASTM D 2794 0.500 inch diameter hemispherical head indenter, equal to 1.5 times the metal thickness in mils, expressed in inch-pounds, with no cracking.

e. Abrasion Resistance Test - When subjected to the falling sand test in accordance with ASTM D 968, Method A, the coating system must withstand a minimum of 2.83 cubic feet (80 liters) of sand before the appearance of the base metal. The term "appearance of base metal" refers to the metallic coating on steel or the aluminum base metal.

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: Few manufacturers regularly produce prefinished panels meeting these low gloss requirements and such sheets are available only in limited colors. Standard 70 percent PVF2 finish, for example, has a medium gloss. Low gloss paint formulations result in reduced weathering properties. The project program must identify individual facilities requiring low gloss finish.  
For roof of structures at airfields where glare would be objectionable and may be an operational hazard, the specular gloss value should be limited to 10 or less at an angle of 85 degrees.  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

f. Specular Gloss - Where considerations for flight line visibility (or other considerations) mandate, finished roof surfaces must have a specular gloss value of 10 or less at an angle of 85 degrees or 30 plus or minus the value specified in the project program at 60 degrees when measured in accordance with ASTM D 523.

g. Pollution Resistance - Coating must show no visual effects when covered spot tested in a 10 percent hydrochloric acid solution for 24 hours in accordance with ASTM D 1308.

**B301001 1.5.10 Insulation**

Thermal resistance of insulation must not be less than the R-values shown on the contract drawings. Determine R-values at a mean temperature of 75 degrees F in accordance with ASTM C 518.

a. Polyisocyanurate Rigid Board Insulation for Use Above a Roof Deck - Polyisocyanurate insulation must conform to ASTM C 1289, Type II.

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: The specified blanket insulation is flexible mineral fiber insulation for use at temperatures up to 350 degrees F (176 degrees C).  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***

b. Blanket Insulation - Blanket insulation must conform to ASTM C 991.

c. Glass Mat Gypsum Roof Board - Glass mat gypsum roof board for use above the deck or insulation for thermal protection must have a flame spread - 0, smoke developed - 0, be water resistant and have a compressive strength of 500 psi. Glass mat gypsum roof board must conform to ASTM C 1177/C 1177M.

**B301001 1.5.11 Sealant**

Sealants must be elastomeric type containing no oil or asphalt. Exposed sealant must be colored to match the applicable building color or clear and must cure to a rubber like consistency. Sealant placed in the roof panel standing seam ribs must be provided in accordance with the manufacturer's recommendations.

**B301001 1.5.12 Vapor Retarder**

a. Vapor Retarders as Integral Facing - Alloy conforming to ASTM B 209, temper as required for the forming operation, minimum 0.032 inch thick. Insulation facing must have a permeability of 0.02 perm or less when tested in accordance with ASTM E 96.

b. Vapor Retarders Separate from Insulation - Vapor retarder material must be polyethylene sheeting conforming to ASTM D 4397. A single ply of 10 mil polyethylene sheet; or, at the Contractor's option, a double ply of 6 mil polyethylene sheet must be used. A fully compatible polyethylene tape with equal or better water vapor control characteristics than the vapor retarder material must be provided. A cloth industrial duct tape in a utility grade must also be provided to use as needed to protect the vapor retarder from puncturing.

**\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: A slip sheet is required to separate the roofing panels from the insulation facing where the facing would be in direct contact with the roofing panels.  
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c. Slip Sheet for Use with Vapor Retarder - Slip sheet for use with vapor retarder must be a 5 lb. per 100 square feet rosin-sized, unsaturated building paper.

**B301001 1.5.13 EPDM Rubber Boots**

Flashing devices around pipe penetrations must be flexible, one-piece devices molded from weather-resistant EPDM rubber. Rubber boot material must be as recommended by the manufacturer. The boots must have base rings made of aluminum or corrosion resisting steel that conform to the contours of the roof panel to form a weather-tight seal.

**B301001 1.5.14 Prefabricated Curbs and Equipment Support**

Prefabricated curbs and equipment supports must be of structural quality, hot-dipped galvanized or galvanized sheet steel, factory primed and prepared for painting with mitered and welded joints. Provide integral base plates and water diverter crickets. Minimum height of curb must be 8 inches above finish roof. Construct curbs to match roof slope and to provide a level top surface for mounting of equipment. Curb flange(s) must be constructed to match configuration of roof panels. Coordinate curb size prior to curb fabrication with the mechanical equipment to be supported. Coordinate strength requirements for equipment supports to include all anticipated loads. Flashings must not be rigidly attached to underlying structure.

**B301002 LOW SLOPE ROOF SYSTEMS**

**B301002 1.1 GENERAL REQUIREMENTS**

a. Warranty (Except SSMRS) - Furnish the roofing system manufacturer's materials and workmanship warranty for the roofing system. The warranty period must not be less than 20 years from the date the Government acceptance of the work. The warranty must be issued directly to the Government and will not be limited in dollar value. The system warranty must include roofing membrane, insulation, flashings, accessories and attachments.

b. Wind Uplift - The complete roof covering assembly must be rated in accordance with FM P7825, capable of withstanding an uplift pressure as determined by ASCE/SEI 7, and FM 1-49 for perimeter and flashing attachment.

c. Fire Safety - The complete roof covering assembly shall meet ASTM E 108, Class 1A or UL 790, Class A; and be listed as Fire-Classified roof deck construction in the UL Roofing Materials and Systems Directory (RMSD), or Class I roof deck construction in FM P7825. All components of the system must be UL labeled. Complete roof covering assembly must: **\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*   
NOTE: Specify Class B option only when Class A may not be attainable such as membrane system application directly to wood deck. Provide justification/rationale for Class B option with design submission  
\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\***  
1) Be Class A or B rated in accordance with ASTM E 108 , FM 4470, or UL 790; and2) Be listed as part of Fire-Classified roof deck construction in UL RMSD, or Class I roof deck construction in FM P7825c.

d. Traffic Pads - Provide on roof system to protect roof from foot traffic. Provide traffic pads from roof access to and around roof mounted mechanical equipment and underneath removable mechanical equipment access panels. Traffic pads must be of compatible material to roof.

e. Cool Roof - If required in RFP Part 2 or Part 3 comply with UFC 3-110-03, Roofing Chapter 1, Cool Roofs. Cool roof design must follow the requirements in UFC 3-110-03, *Roofing*, Chapter entitled "Cool Roofs".

**B301002 1.2 BUILT-UP ASPHALT ROOFING (AGGREGATE SURFACED)**

This paragraph covers the requirements for aggregate surfaced bituminous built-up roofing made up of glass felt, asphalt bitumen, and aggregate surfaced or modified bitumen cap sheet.

**B301002 1.2.1 Materials**

a. Asphalt - ASTM D 312, Type II, III or IV

b. Felts - Base Sheet (GB) – ASTM D 4601, Type II without perforations   
  
1) Ply Felt (GA) – ASTM D 2178, Type IV or VI   
  
2) Ventilating Base Sheet VB) – ASTM D 4897   
  
3) Flashing Felt (SBS Modified Base Sheet - MB) in accordance with ASTM D 6162 (with combined polyester and glass fiber reinforcing), Type II, Grade G (weighing 4.3(90 lbs./100sf), and a thickness of 130 mils) or Grade S (weighing 58 lbs./100sf and a thickness of 85 mils), ASTM D 6163 (with glass fiber reinforcing), Type II, Grade G (weighing 90 lbs./100sf, and a thickness of 130 mils) or S (weighing 58 lbs./100sf and a thickness of 85 mils), ASTM D 6164 (with polyester reinforcing), Type II, Grade G (weighing 90 lbs./100sf, and a thickness of 130 mils) or S (weighing 70 lbs./100sf and a thickness of 115 mils).   
  
4) SBS Bitumen Cap Sheet (RSS) – ASTM D 6162 (with combined polyester and glass fiber reinforcing), Type II, Grade G (weighing 90 lbs./100sf, and a thickness of 130 mils), ASTM D 6163 (with glass fiber reinforcing), Type II, Grade G (weighing 90 lbs./100sf, and a thickness of 130 mils), ASTM D 6164 (with polyester reinforcing),

c. Primer - ASTM D 41

d. Asphalt Roof Cement - ASTM D 4586, Type II for vertical surfaces and Type I for horizontal surfaces.

e. Aggregate for Surfacing Built-up Roofing - ASTM D 1863

f. Fasteners - Provide metal fasteners of copper, aluminum or stainless steel, compatible with materials to be penetrated. Fasteners must be of sufficient length to achieve appropriate embedment or penetration into the substrate below.

g. Metal Discs - Flat discs or caps of zinc-coated steel not less than 28 gage and not less than 1-3/8 inches (35 mm) in diameter.

h. Traffic Pads - Preformed reprocessed rubber, compatible with the roof membrane, 1/4-inch (6.35 mm) minimum thickness, weighing not less than 1-1/2 pounds per square foot, to protect roof from foot traffic. Provide traffic pads around roof access and around roof mounted equipment and underneath removable mechanical equipment access panels.

**B301002 1.2.2 FIELD QUALITY CONTROL**

a. Tests for Surface Dryness - see paragraph B301002 1.2 for Performance Verification and Acceptance Testing requirements.

**B301002 1.3 MODIFIED BITUMINOUS MEMBRANE ROOFING**

This paragraph covers the requirements for modified bituminous membrane sheet roofing, SBS modified for hot mopping or cold applied, with a minimum slope of 1/2 inch per foot. Provide a complete modified bitumen roofing system, to include insulation, flashings, felts, primers and adhesives as recommended for the installation either on a nailable (plywood or metal deck) or non-nailable (concrete) substrate, from the materials below. All work must follow the NRCA RoofMan guidelines and standards stated within this Section.

**B301002 1.3.1 Materials**

a. Asphalt - ASTM D 312, Type III or IV.

b. Ply Materials -   
  
1) Ventilating Base Sheet (VB) – ASTM D 4897, Type II   
  
2) Base Sheet (GB) – ASTM D 4601, ASTM D 1668, Type II without perforations   
  
3) SBS Modified Base Sheet (MB) – ASTM D 6162 (with combined polyester and glass fiber reinforcing), Type II, Grade S weighing 58 lbs./100sf and a minimum thickness of 85 mils), ASTM D 6163 with glass fiber reinforcing), Type II, Grade S (weighing 58 lbs./100sf and a minimum thickness of 85 mils), ASTM D 6164 (with polyester reinforcing), Type II, Grade S (weighing 70 lbs./100sf and a minimum thickness of 115 mils).   
  
4) SBS Interply Sheet: ASTM D 6162, ASTM D 6164, ASTM D 6163, Type I or II, Grade S, minimum 80 mils (2.0 mm) thick.   
  
5) SBS Bitumen Cap Sheet (RSS) – ASTM D 6162 (with combined polyester and glass fiber reinforcing), Type II, Grade G (weighing 90 lbs./100sf, and a minimum thickness of 145 mils), ASTM D 6163 (with glass fiber reinforcing), Type II, Grade G (weighing 90 lbs./100sf, and a minimum thickness of 145 mils), ASTM D 6164 (with polyester reinforcing), Type II, Grade G (weighing 90 lbs./100sf, and a minimum thickness of 145 mils). Provide polyester reinforced cap sheet on roofs expected to experience high levels of traffic, on roofs with congested equipment, where equipment is expected to receive regular service or high maintenance, and where other service conditions warrant.

c. Mineral Roofing Granules - Factory applied, requiring no further coating.

d. Primer - ASTM D 41

e. Asphalt Roof Cement - ASTM D 4586, Type II for vertical surfaces, Type I for horizontal surfaces.

f. Fasteners - Provide non-corrosive fasteners meeting the requirements of FM A/S4470.

g. Asphalt Adhesive - ASTM D 4479, Type III.

h. Reflective Coating - 100% Acrylic Elastomeric with Energy Star Rating exceeding the requirements of ASTM D-6083. Coating must be intended for use as a roof topcoat.

**B301002 1.4 STRUCTURAL STANDING SEAM METAL ROOFING**

See B301001 1.5.1 "Structural Standing Seam Metal Roof System" for SSSMR requirements.

**B301003 ROOF INSULATION & FILL**

Coordinate the insulation system with the mechanical design to suit the energy requirements of the facility.

**B301003 1.1 MINERAL FIBER BLANKET INSULATION**

This paragraph covers the requirements for mineral fiber blanket thermal insulation in attics and above ceilings.

**B301003 1.1.1 Products**

a. Blanket Insulation - ASTM C 665, Type I, II, or III, as appropriate for the installation, Class A, membrane-faced surface with a flame spread of 25 or less; and a smoke developed rating of 150 or less when tested in accordance with ASTM E 84. Indicate insulation R-values on the design drawings.

b. Blocking – Treated wood, metal, un-faced mineral fiber blankets in accordance with ASTM C665, Type I. Blocking around chimneys and other heat producing devices must be non-combustible and meet the requirements of ASTM E 136.

c. Vapor Retarder - 6 mil (minimum) thick polyethylene sheeting conforming to ASTM D 4397, with a water permeance value of 1 perm or less when tested according with ASTM E 96.

**B301003 1.2 ROOF AND DECK INSULATION**

This paragraph covers the requirements for insulation materials used below the roofing systems.

**B301003 1.2.1 Insulation Types**

Roof insulation must have an R-value determined in accordance with UFC 3-101-01 *Architecture*, and American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) Standard 90.1 and meet project energy goals and be one or an assembly of a maximum of three of the following materials and compatible with attachment methods for the specified insulation and roof system:

a. Polyisocyanurate Board – ASTM C 1289, with a minimum compressive strength of 138 kPa (20 psi), unless overlaid with another board with a comparable or greater compressive strength. Use insulation facer as recommended by the roofing material manufacturer. Board size is restricted to 4' by 4' when applied in direct contact with concrete deck.

b. Extruded Polystrene (XPS) Board - ASTM C 578, Type IV or X, and 4' by 4' board size.

c. Composite Boards – ASTM C 984 (Polyisocyanurate-perlite) or ASTM C 1289, Type III, or ASTM C 1289, Type V, oriented strand board or waferboard on one side and fibrous felt or glass fiber mat membrane or aluminum foil on the other.

d. Expanded Perlite Board - ASTM C 728, minimum thickness of 3/4" board, and 4' by 4' board size.

**B301003 1.2.2 Tapered Roof Insulation**

On portions of the roof where the sloping of structure does not allow the minimum slopes, provide a factory tapered roof insulation system to provide positive drainage of roof system, and to include drainage around curbs, penetrations, and projections through the roof plane. For new construction, provide one layer of the tapered roof insulation assembly factory tapered to a slope not less than 1/2" per foot (13 mm per 300 mm). For re-roofing applications where slopes of 1/2" per foot (13 mm per 300 mm) cannot be achieved, provide a minimum of 1/4" per foot (6.35 mm per 300 mm) slope.

**B301003 1.2.3 Protection Board**

Provide for use as a thermal barrier (underlayment) or protection board for hot-mopped applications.

**B301003 1.2.4 Glass Mat Gypsum Roof Board**

ASTM C 1177, with a 0 Flame Spread and 0 Smoke Developed when tested in accordance with ASTM E 84, 500 psi (2450 kPA), Class A.

**B301003 1.2.5 Bitumens**

a. Asphalt Primer - ASTM D 41

b. Asphalt - ASTM D 312, Type III or IV

c. Asphalt Roof Cement - ASTM D 4586, Type I for horizontal surfaces, Type II for vertical and sloped surfaces. Roof cement must be compatible with membrane materials.

**B301003 1.2.6 Underlayment**

a. Asphalt-Saturated Felt Base Sheet for Single Layer Application - ASTM D 4869, Type II or ASTM D 226, Type II (30 pounds).

b. Polymer-Modified Self-Adhering Bitumen Sheet, 40 mil (1.1 mm) minimum thickness. Provide at roof perimeter, valley and roof penetration locations as a minimum.

**B301003 1.2.7 Seal at Penetrations**

Provide pre-manufactured flashing components for use in single-ply roofing applications. Seal laps and penetrations to prevent moisture vapor penetration. Adhesives, sealants, prefabricated components and spray foam products may be required.

**B301003 1.2.8 Fasteners**

Fasteners must be flat, round or hexagonal steel (not less than 1-3/8"(35 mm) diameter) and 28 gage, or plastic plates (not less than 3 inches (75 mm) in diameter).

Fasteners in lightweight cellular concrete decks must penetrate at least 1 inch (25 mm) but not more than 1-1/2 inches (32 mm) into the deck. Withdrawal resistance from lightweight cellular concrete deck must not be less than 40 lbs.(18 kg) each, or 120 lbs. (54 kg) each in metal deck.

Fasteners in steel decks must be hardened fasteners or screws conforming to FM A/S4470 and listed in FM P7825 for Class I roof deck construction.

Fasteners must be place to withstand an uplift pressure required by the project program in the field of the roof and FM Loss Prevention Data Sheets (LPDS) 1-49 for perimeter component and flashing attachment.

Roofing Nails - Provide corrosion resistant ring shank nails of sufficient length to penetrate a minimum of 1 inch (25 mm) into wood nailers or so as to provide appropriate embedment in substrate below. Fasteners must conform to FM A/S4470, and be placed to withstand an uplift pressure of 90 psf (4.3 kPa) conforming to FM P7825, and FM 1-49 for perimeter fasteners.

**B301003 1.2.9 Wood Nailers**

Wood nailers must be pressure-preservative-treated in accordance with AWPA M2 Standards, permanently marked or branded, and installed flush with the top of the adjacent insulation board. Separate treated wood nailers from roofing metals with underlayment.

**B301003 1.2.9.1 Fasteners**

Provide stainless steel, double hot-dipped galvanized or other corrosion resistant fasteners recommended by the treatment manufacturer for use with treated wood.

**B301004 FLASHINGS & TRIM**

**B301004 1.1 FLASHING AND SHEET METAL**

This paragraph covers the requirements for flashing and sheet metal work including scuppers, splash pans, and sheet metal roofing. Provide flashing and sheet metal in accordance with roof manufacturer’s printed installation instructions and in compliance with NRCA and SMACNA recommendations.

**B301004 1.1.1 Materials**

Furnish sheet metal items in minimum 8 to 10 foot (2.44 to 3.05 meter) lengths. Sheet metal items include the following: gutters, including hangers; downspouts; counter-flashings; gravel stops and fascias; cap, valley, stepped, base and eave flashings and related accessories.

a. Copper, Sheet and Strip - ASTM B 370, cold-rolled temper.

b. Lead-Coated Copper Sheet - ASTM B 101

c. Lead Sheet - Minimum weight 4 pounds per square foot (.19 kPa).

d. Steel Sheet, Zinc-Coated (Galvanized) - ASTM A 653/ A 653M. Galvanized steel items must have a baked-on, factory applied finish of polyvinylidene fluoride or an equivalent fluorocarbon coating with a minimum thickness of 0.8 to 1.3 mils.

e. Stainless Steel - ASTM A 167, Type 302 or 304, 2D finish, fully annealed, dead-soft temper.

f. Aluminum Alloy Sheet and Plate - ASTM B 209

g. Pre-Finished Aluminum - Provide trim, gravel stops and fascias of Pre-finished aluminum. Finish must be baked-on factory applied color coating of polyvinylidene fluoride (PVF2) or other equivalent fluorocarbon coating with a minimum thickness of 0.8 to 1.3 mils.

h. Aluminum alloy, Extruded Bars, Rods, Shapes, and Tubes - ASTM B 221

i. Solder - ASTM B 32

j. Polyvinyl Chloride Reglet - ASTM D 1784, Type II

k. Asphalt Primer - ASTM D 41

l. Fasteners - Fasteners must be of the same or compatible metal with the item being fastened. Stainless steel fasteners must be used to fasten dissimilar materials.

**B301004 1.1.2 Field Quality Control**

Fabrication and installation of sheet metal items must be as follows:

a. Install work with watertight and hairline joints, without waves, warps, buckles, fastening stresses, or distortion, allowing for expansion and contraction.

b. Make surfaces to receive sheet metal plumb and true, clean, even, smooth, dry and free of defects and projections that could affect the application.

c. Provide sheet metal flashing in angles formed where roof decks abut walls, curbs, ventilators, pipes, or other vertical surfaces and wherever indicated and necessary to make the work watertight.

d. Provide prefabricated inside and outside corners at all sheet metal intersection pieces. Minimum leg length must be 12 inches (300 mm), maximum length must be 18 inches (450 mm).

e. Fabricate sheet metal to conform to the contours of surfaces to which applied.

f. All sheet metal cap flashings must have waterproof membrane underlayment installed behind or below the metal components.

g. Provide conforming sheet metal closures at all flashing termination conditions.

h. Provide fastenings and accessories as required to provide a securely attached, watertight construction. Cleats must be a minimum of one gage heavier than the component to be attached.

i. Where sheet metal components are to be embedded in the roofing system, prime both sides of all metal flanges prior to installation.

**B301005 GUTTERS AND DOWNSPOUTS**

Provide gutters and downspouts compatible with roofing material and finish. Concealed (interior) gutters and downspouts are prohibited. The primary and secondary drainage systems must be sized in accordance with applicable Plumbing and Building Codes. Finish must be baked-on factory applied color coating of polyvinylidene fluoride (PVF2) or other equivalent fluorocarbon coating with a minimum thickness of 0.8 to 1.3 mils.

**B301006 ROOF OPENINGS AND SUPPORTS**

**B301006 1.1 GENERAL REQUIREMENTS**

Provide flashings for roof openings and supports as recommended by the NRCA and as specified below:

When existing pitch pans cannot be avoided and must be utilized, insure pitch pan is a preformed pan with minimum 4-inch (100 mm) height and 2-inch (50 mm) flange with 2-inch (50 mm) clearance on all sides of the penetration. Fill bottom 1/3 with non-shrink grout. Fill remainder with pourable elastomeric sealer sloped to drain. For round penetrations, provide a metal umbrella cap clamped to the penetration.

Assure all penetration flashings extend minimum 8 inches (200 mm) above the finished roof surface. Use round shapes to construct equipment supports. Equipment supports should be raised on a continuous curb a minimum of 14 inches (350 mm), but not less than as required by the NRCA.

**B301006 1.2 ROOF HATCHES**

Construct using NRCA approved techniques and details. Provide roof hatch where required by Occupational Safety and Health Administration (OSHA), or as access to roof when roof mounted equipment is used or other routine roof maintenance is required.

**B301006 1.2.1 Construction**

Provide insulated roof hatches of 14 gage galvanized steel with 22 gage galvanized steel liner or 18 gage aluminum liner, and have integral curb, flange and flashings for securing to roof deck. Hinge must be heavy-duty zinc plated steel with non-removable pins. Latching mechanism must be zinc-coated steel slam latch with inside and outside levers. Springs must be greased compression springs in telescopic tubes. Provide interior locking of roof hatch. Provide a safety rail or ladder extension. Size roof hatch to allow access of routine maintenance equipment, but not less than 2'-6" x 3'-0" (750 mm x 900 mm). Hatch and access ladders must conform to OSHA and other applicable safety standards.

**B301006 1.3 GLAZED ROOF OPENINGS**

This paragraph covers the requirements for skylights manufactured from glass-fiber or thermoplastic carbonate.

Skylights and other glazed roof openings must be used only to supplement interior lighting levels (generally in steep slope or vertical applications), and otherwise, are discouraged from use. Proper detailing is critical, and must be scrutinized closely to minimize the likelihood of future leaks at these locations.

**B301006 1.3.1 Warranty**

Furnish to the Government the manufacturer's complete warranty for materials, workmanship and installation. The warranty is for 10 years from the time of project completion. The warranty must guarantee, but will not be limited to, the following:

a. Light transmission and color of the panels will not change after exposure to heat of 300 degrees F (149 degrees C) for 25 minutes.

b. There is no delamination of the panel affecting appearance, performance, weatherability or structural integrity of the panels or the completed system.

c. There is no fiberbloom on the panel face.

d. Change in light transmission of no more than 6% in accordance with ASTM D 1003, and in color (yellowing index) no more than 10 points in comparison to the original specified value over a 10-year period.

**B301006 1.3.2 Skylight Panels**

Skylight panels must be constructed of glass-fiber reinforced polyester or extruded cellular thermoplastic polycarbonate materials. Glass-fiber reinforced panels must conform to ASTM D 3841 and to the requirements of American Architectural Manufacturers Association (AAMA) 1600/I.S.7.

a. Non-Combustible Grid Core - The aluminum I-beams must be 6063-T6 with provisions for mechanical interlocking of muntin-mullion and perimeter to provide full bonding surface to contact the face material. Panels must withstand 1200 degrees F (650 degrees C) for a minimum of one hour without collapse or exterior flaming.

b. Adhesive - The laminate adhesive must meet the following requirements:

1) Tensile strength of 750 psi-in. in accordance with ASTM C 297.

2) Shear strength must meet or exceed the following in accordance with ASTM D 1002:

a) 540 psi (3723 kPa) at 50% relative humidity and 73 degrees F (23 degrees C).

b) 800 psi (5516 kPa) under accelerated aging in accordance with ASTM D 1037 at room temperature.

c) 250 psi (1724 kPa) under accelerated aging in accordance with ASTM D 1037 at 182 degrees F (83 degrees C).

d) 1400 psi (9653 kPa) after 500-hour Oxygen Bomb in accordance with ASTM D 572.

e) 100 psi (690 kPa) at 182 degrees F (83 degrees C).

c. Panel Construction - Panels must consist of fiberglass faces laminated to an aluminum I-beam grid core and must not deflect more than 1.9 inches (48 mm) at 30 psf (1.44 kPa) in 10 feet (3.048 meters) in accordance with ASTM E 72, without a supporting frame.

**B301006 1.3.3 Thermoplastic Polycarbonate Panels**

The glazing panels must meet the following requirements:

a. The interior flame spread classification must be Class I in accordance with ASTM E 84, with a smoke developed rating no greater than 70 in accordance with ASTM D 2843.

b. The exterior and interior faces must be an approved light transmitting panel with a CC1 fire rating classification in accordance with ASTM D 635.

c. Self-ignition must be greater than 1058 degrees F (570 degrees C) in accordance with ASTM D 1929.

d. Fire rated roof assembly translucent panels must be successfully evaluated for fire from exterior exposure in accordance with ASTM E 108 to meet Class 'A' rating, and be listed by an independent recognized listing laboratory.

**B301006 1.4 GUARDS**

Provide rails or guards as required by the OSHA, the International Building Code or other applicable safety standards.

**B301090 OTHER ROOFING**

**B301090 1.1 LIGHTNING PROTECTION**

Lightning protection component penetrations and attachments must be sealed and flashed and anchored in a permanent manner and in a manner to avoid the degradation of the watertight integrity of the roof system. Do not cut or otherwise disturb the roof membrane. Mastic seals in the plane of the roof are unacceptable. Anchor plates set in mastic must be set on roof surface cleaned of aggregate and loose material prior to mastic application.

**B301090 1.2 ROOF DRAINS (EXISTING)**

Where existing roof drains are to be reused in roof replacement construction, provide new, compatible flashing materials, a new drain clamping ring and new bolts for anchorage. Reuse of existing clamping ring and bolts is unacceptable.

**B301090 1.3 VEGETATED ROOFS**

Where vegetated roofs are specified, provide additional technical specification for Government approval. Refer to UFC 3-110-03 and Whole Building Design Guide section titled "[Vegetated Roof Covering](https://www.wbdg.org/ffc/epa/federal-green-construction-guide-specifiers/07-33-63) ".

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