SECTION 07110

DAMPPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing dampproofing.

B. Related Work Specified Elsewhere:
   1. Cast-in-Place Structural Concrete: Section 03300.
   2. Cast-in-Place Architectural Concrete: Section 03331

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Product data for each type of product specified, including data substantiating that materials comply with requirements for each dampproofing material specified. Include recommended method of application, recommended primer, number of coats, coverage or thickness, and recommended protection course.

B. Certification:
   1. Certification that materials furnished meet specified requirements and are compatible with each other.
   2. Certification by dampproofing manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs).

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Codes and regulations of the jurisdictional authorities.
   2. ASTM: D41, D449.

B. Demonstration Area:
   1. Prepare 100-square foot specimen of typical dampproofing application using specified methods and materials.
   2. Location of demonstration area as directed. Dampproofing will be visually and physically examined by the Engineer.
   3. If demonstration area is disapproved, prepare additional demonstration area. Do not proceed with dampproofing until demonstration area has been approved. Approved demonstration area will serve as the standard of quality and workmanship for dampproofing work specified in this section.

C. Installer Qualifications: Engage an experienced Installer who has completed bituminous dampproofing similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to the jobsite in their original unopened containers clearly labeled with manufacturer's name, brand designation, referenced specification number, type and class, as applicable.

B. Store products in approved dry area, protected from contact with soil and from exposure to the elements. Keep products dry.

C. Handle products so as to prevent breakage of containers and damage to products.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
   1. Application of dampproofing to unprotected surfaces in wet weather or to surfaces on which ice, frost, water or dampness is visible is prohibited.
   2. Application of dampproofing when ambient temperature is below 40F is prohibited.

B. Substrate: Proceed with dampproofing only after substrate construction and penetrating work have been completed.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Asphalt Primer: ASTM D41.

B. Asphalt: ASTM D449, Type A.

C. Portland Cement Grout: Section 04050.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Do not start dampproofing until requirements for curing concrete have been completed and surfaces have thoroughly dried.

B. Clean surfaces to be dampproofed of loose and foreign material, concrete fins and dirt.

C. Moisten and point holes, honeycombs, cracks, cavities and concrete fill with portland cement grout and allow to cure completely before covering. See Section 03300 for curing and protection.

3.02 APPLICATION:

A. Apply dampproofing, consisting of two prime coats and one seal coat of dampproofing materials, to surfaces shown to receive dampproofing.
   1. Apply two coats of primer to surfaces to be dampproofed at rate of one gallon per 100 square feet. Allow first coat to dry thoroughly before second coat is applied.
   2. Do not heat prime-coat material for application.
   3. After second prime coat has thoroughly dried, brush one coat of hot asphalt as applicable over primed surface at minimum rate of 15 pounds per 100 square feet of surface; fill cracks, voids and crevices.
   4. Do not heat asphalt in excess of 400F.
   5. Apply dampproofing coat so as to ensure continuous surface free of dull or porous spots. Give dull or porous spots additional coating of hot asphalt.
   6. Perform finished work to conform to dimensions shown; do not disfigure other areas or parts of structure by dripping or spreading of materials.

3.03 PROTECTING AND CLEANING:

A. Protect finish work during application of dampproofing and repair damage.

B. Remove spots and spattering of the dampproofing from finish work and leave the entire work area in first-class condition.

C. Remove dampproofing rubbish from the premises and leave spaces in broom-clean condition.

END OF SECTION

SECTION 07125

MEMBRANE WATERPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing fluid-applied membrane waterproofing, rubberized-asphalt sheet membrane waterproofing and protection courses.

B. Related Work Specified Elsewhere:
   1. Cast-in-Place Structural Concrete: Section 03300.
   2. Cast-in-Place Architectural Concrete: Section 03331.
   3. Brick: Section 04215.
   4. Concrete block: Section 04220.
   5. Mortar: Section 04050.

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Product Data: Include manufacturer's written instructions for evaluating, preparing, and treating substrate, technical data, and tested physical and performance properties of waterproofing.
   2. Shop Drawings: Show locations and extent of waterproofing. Include details for substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins to adjoining waterproofing, and other termination conditions.
      a. Include joint and anchorage details, materials and description of sequence of operation.
   3. Samples: Four of each type of the following materials used in the work:
      a. Membrane: 12 inches square.
      b. Adhesive: Half-pint containers.
      c. Butyl gum tape: Small rolls.
      d. Hardboard: 12 inches square.
      e. Protection board: 12 inches square.

B. Certification:
   1. Certification that materials furnished meet specified requirements and are compatible with each other.
   2. Certification that the applicator is approved by the manufacturer.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. American Hardboard Association Industry: AHAI Standard 1.
   3. FS: TT-S-230.
   4. ASTM: A123, C42, C78, C90, C171, C192, C272, C293, E96, D41, D146, D226, D412, D449, D572, D638, D790, D1621, D1668, D4586, E96, E154.

B. Qualifications of Waterproofing Applicator:
   1. Use applicator who is approved by the manufacturer.

2. Employ workers who have had experience in waterproofing of specified type on jobs of similar size and comparable structures. Have approved full-time superintendent or foreman supervise and direct waterproofing operations.
3. Inform the Engineer of proposed schedules and locations of waterproofing work.

C. Obtain waterproofing materials, sheet flashings, and protection course through one source from a single manufacturer.

D. Pre-installation Conference: Conduct conference at Project site. Review requirements for waterproofing, including surface preparation specified under other Sections, substrate condition and pretreatment, minimum curing period, forecasted weather conditions, special details and sheet flashings, installation procedures, testing and inspection procedures, and protection and repairs.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to job site in original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type and class, as applicable.

B. Store products in approved dry area with roll goods standing on ends. Protect from contact with soil and from exposure to the elements. Keep products dry.

C. Handle products so as to prevent breakage of containers and damage to products.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
1. Application of waterproofing to unprotected surfaces in wet weather or to surfaces on which ice, frost or dampness is visible is prohibited.
2. Unless otherwise approved, application of waterproofing unless ambient temperature is at least 40F and rising is prohibited.
3. Maintain rolls of material at a temperature of at least 50F for a period of not less than 24 hours prior to installation.

B. Provide ventilation in accordance with specified safety requirements.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Asphalt: ASTM D449, Type A.

B. Asphaltic Primer: ASTM D41

C. Glass Fabric: ASTM D1668, Type I or III.

D. Asphalt-Saturated Felt: ASTM D226, Type I.

E. Asphalt Cement (Asbestos-Free): ASTM D4586.

F. Waterproof Building Paper: ASTM C171, Regular.

G. Rubberized-Asphalt Sheet Membrane Waterproofing: Tough, pliable self-adhering waterproofing sheet of polyethylene film, coated on one side with a layer of adhesive-consistency rubberized asphalt, with the following additional requirements:

Characteristic	Value	Test Method
Thickness:		
a. Polyethylene film	4 mils	-
b. Rubberized asphalt	56 mils	-
c. Rubberized asphalt membrane total	60 mils	-
Permeance	0.1 perm	ASTM E96 Method B
Pliability, 180-degree bend over 1/4-inch mandrel at minus 30F	Unaffected	ASTM D146
Peel adhesion, 7 days dry plus 7 days at 120F plus 7 days dry or 7 days wet	5.0 pounds per inch, minimum	FS TT-S-230 Modified
Cycling over crack 15F, crack opened and closed from 0 inches to 1/4 inch	No effect 100 cycles	-
Puncture resistance, membrane	40 pounds minimum	ASTM E154
Tensile strength, membrane	250 pounds per square inch minimum	ASTM D412 Die C Modified

H. Asphaltic Mastic:
1. Solvent-base, containing synthetic rubber, asphalt and other components, suitable for troweling, as recommended by membrane manufacturer.
2. Dry-film requirements:
   a. Aging: No cracking, flowing, crazing, blistering, or delamination when subjected to 192 hours in oxygen bomb at 158F and 300-psi oxygen pressure in accordance with ASTM D572.
   b. Water permeability: 0.05-perm maximum when applied 1/32-inch thick over kraft paper and tested in accordance with ASTM E96.
   c. Stress: No cracking or delamination when 1/64-inch thick layer is applied on metal and bent five times 360 degrees at zero F on 1/16-inch mandrel.

I. Bonding and Joining Materials for Butyl Membrane:
1. Adhesive: For bonding butyl membrane to adjacent surfaces, as recommended by manufacturer of sheeting material.
2. Butyl compound: Self-vulcanizing for splicing joints in butyl membrane, as recommended by manufacturer.

3. Butyl gum tape: Unvulcanized butyl-gum rubber with polyethylene-backing material for splicing tape, as recommended by membrane manufacturer.
4. Flexible butyl-sheet rubber for flashings: As recommended by membrane manufacturer and as specified.

J. Protection Course Materials:
1. Concrete: Section 03300, class as shown.
2. Concrete block: Section 04220, ASTM C90, Type I.
3. Common brick: Section 04215, type and grade as shown
4. Concrete plank: Lightweight, reinforced-concrete plank, tongue-and-groove sides and ends, 16 inches wide, two inches thick, 10 feet long.
5. Protection board:
   a. Semi-flexible board, five ply or more, composed of asphaltic core sealed under heat and pressure between two liners of asphalt-saturated kraft paper or felt bonded to independent waterproofing during manufacturing process. Thickness as recommended by manufacturer.
   b. Extruded, rigid polystyrene-foam board, one-inch thick. Compressive strength 25-psi minimum, ASTM D1621; water absorption 0.1 percent, ASTM C272.
   c. Portland-cement mortar: Section 04050.

K. Epoxy-Injection Material for Repair of Leaks: Two-part epoxy-adhesive materials, containing 100-percent solids, having aromatic curing-agent surface M-phenylanediamine and meeting or exceeding the following minimum requirements:
1. Flexure strength: 400 psi in accordance with ASTM D790.
2. Tensile strength: 1,200 psi in accordance with ASTM D638.
3. Bond strength: ASTM C293 and as follows:
   a. Prepare concrete-beam test specimen in accordance with ASTM C192, using concrete mix design for 1-1/2 inch aggregate.
   b. Break concrete beam in accordance with ASTM C78.
   c. Bond broken beam using epoxy with bond-line thickness of 20 mils and cure for seven days at constant temperature of 65F.
   d. After curing, rebreak beam in accordance with ASTM C78.
   e. Attain specified values of flexure and tensile strength for repaired beam.
   f. Cores taken for testing in accordance with ASTM C42.

L. Protection-Board Adhesive: As recommended by the protection-board manufacturer.

2.02 WATERPROOFING SYSTEMS:

A. Fluid-Applied Membrane System:
1. Asphaltic primer.
2. Membranes: One of the following:
   a. Glass fabric.
   b. Asphalt-saturated felt.
3. Accessories:
   a. Asphaltic mastic.
   b. Asphalt cement.
   c. Butyl-gum tape.
   d. Boots.
   e. Iron clamps and bolts: Hot-dip, galvanized, ASTM A123, Grade 100; ASTM A153 Class A.

B. Rubberized-Asphalt Sheet Membrane System:
1. Asphaltic primer.

2. Rubberized-asphalt membrane.
3. Accessories:
    a. Asphaltic mastic.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Place membrane waterproofing after concrete has cured as specified in Section 03300 and surface is completely dry.

B. Keep surfaces thoroughly dry, immediately before and during application of waterproofing.

C. Should surface of the concrete become temporarily damp, dry surface.

D. Remove laitance, dust, dirt, projections, oil, grease and other matter by brooming, scraping, air-hosing or combination of such methods. Surface to be approved prior to application of waterproofing material.

E. Provide one-inch asphaltic mastic cants (fillets) in internal corners.

F. Prepare preconstructed protection of courses where shown in accordance with recommendations of membrane manufacturer. Fill holes and grooves.

G. Treat vertical surfaces with trowel coat of asphalt cement to fill pores and irregularities and level low areas to provide smooth surface for application of membrane waterproofing.

3.02 GENERAL INSTALLATION REQUIREMENTS:

A. Tightly fit waterproofing to structure without voids or kinks. Upon completion, allow no cuts, holes, pockets, bulges, wrinkles, folds or creases in surfaces of finished waterproofing; if such defects are present, repair by patching as specified. If waterproofing is damaged, punctured or in any way pervious and cannot be effectively patched or repaired, remove and replace to extent necessary to ensure that structure is waterproof.

B. Mop surfaces to be waterproofed in sections. Begin waterproofing at low point. Allow sufficient fabric for suitable overlap and anchorage at upper edge.

C. If leaks occur in areas where backfilling has not been placed, cut-out waterproofing and protection and patch as necessary to ensure watertight barrier. Where membrane is inaccessible, stop leaks with epoxy injection.

D. Cover horizontal surfaces of membrane waterproofing on which backfill is to be placed with portland-cement concrete of class and thickness shown and as specified in Section 03300.

E. Protect penetrations in membrane, such as pipes, conduits, piles, struts, walers and other braces. Provide sleeves, clamping rings or other approved devices at penetrations and install with counterflashing where shown and mastic tape where needed to ensure watertight joint.

F. Where shown in concrete floors and roof, fill electrical-bonding notches with asphalt cement finished flush with top of concrete.

3.03 FLUID APPLIED MEMBRANE SYSTEM:

A. General:

1. Approximately 24 hours before first mopping is applied, cover concrete surfaces to be waterproofed with one coat of asphaltic primer at minimum rate of one gallon per 100 square feet. Work primer well into surfaces to achieve uniform coating.
2. Completely cover concrete surfaces so that no concrete is left exposed. On fabric surfaces, apply mopping sufficiently heavy to conceal weave completely. For each mopping use not less than 4-1/2 gallons per 100 square feet of surface.
3. Regulate the work so that installed membrane receives final asphalt mopping before end of day. Thoroughly seal laps.
4. Before applying membrane on exterior of expansion and construction joints, lay strip of waterproof building paper twelve inches wide; extend six inches on each side of joint and secure to surface near edges using approved method.
5. Do not permit one layer of membrane to touch another layer, or concrete surface; separate each by mopped coat of hot asphalt.
6. At edges of membrane, insert membrane into reglets as shown and caulk with approved mixture of asphalt cement, or butyl-gum tape and necessary boots to prevent water intrusion between waterproofing and surface being waterproofed.
7. Where pipes, sleeves for pipes, or drains, penetrate surfaces to be waterproofed, provide synthetic-membrane flashings and two additional plies of membrane extending at least one-foot beyond edge of flashing, set in place with hot moppings of asphalt. Where flashing sleeves are not shown, flash membrane onto pipe or conduit with hot moppings of asphalt and secure with galvanized-iron clamps and bolts or by other approved methods.

B. Heating of Asphalt:

1. Heat asphalt to flow freely not exceeding 350F; stir frequently to avoid local overheating. Provide heating kettles of quality, number and capacity to service work adequately. Keep spare serviceable burners available at site for immediate replacement of malfunctioning burners. Keep kettleman in attendance during operation to ensure that maximum specified temperatures are not exceeded.
2. Employ kettle operators experienced in operating and maintaining type of equipment being used. Provide large metal pans at least one-inch deep under kettle to prevent drippings or fuel leaks from falling on prepared concrete or membraned surfaces. Ensure that each kettle is continuously equipped with calibrated thermometer.
3. Collect strippings from drums daily and remove from site. Set up kettles immediately adjacent to work in progress to reduce carrying distance of hot buckets.
4. Lower hot asphalt with extreme care to avoid endangering workmen in trench or excavation.

C. Two-Ply Work:

1. For first strip of membrane, use half-width; for second, use full-width, lapped full width of first strip.
2. For each succeeding strip, use full-width and overlap so that entire area has two layers of membrane except at joints. Lap joints two inches minimum, producing three plies at such overlaps.
3. Give entire surface final mopping of hot asphalt. When protective covering is shown, place covering on final mopping of asphalt while still hot.

D. Three-Ply Work:

1. Proceed as for two-ply work, except use 1/3-width for first strip; for second strip use 2/3-width; and for the third and succeeding strips use full-width. Overlap strips at least two inches, resulting in surface being completely covered by three plies, with four plies at overlaps.

E. More Than Three-Ply Work:
   1. Build in shingle fashion similar to three-ply work by adding as many plies as are shown. In joining membrane waterproofing to waterproofing in place, clean and heat in-place waterproofing before joining new waterproofing to that previously laid and overlap such joints one-foot minimum.
   2. At intersections of walls with horizontal surfaces, and at other locations, lap the greater number of plies of membrane over the other plies a minimum of one foot.
   3. Reinforce waterproofing at angles and expansion joints and at other locations where membrane may be subjected to unusual strain. Reinforce by means of two additional plies of saturated fabric and alternate moppings of asphalt. At angles between floor and wall provide reinforcing strips of sufficient width to extend six inches minimum on floor and four inches up wall. Extend strips at vertical corners five inches minimum on each side of corner.

F. Patching:
   1. Where the Engineer permits patching of defective waterproofing, extend first patching ply 12 inches minimum beyond outermost edge of defective portion.
   2. Extend second and each succeeding ply of patch three inches minimum beyond preceding ply.
   3. For patch area use at least as many new plies as specified for original membrane.

3.04 RUBBERIZED ASPHALT SHEET MEMBRANE SYSTEM:

A. Prime concrete surfaces as recommended by membrane manufacturer. Do not prime surfaces more than 36 hours prior to applying membrane. Allow primer to dry for one hour or until tack-free. Do not prime metal surfaces, but ensure that they are dry and free of grease, oil, dust, rust and other contaminants.

B. Apply membrane to clean primed surfaces. Lay membrane from low points or drains toward high points in shingle fashion. Overlap each strip 2-1/2 inches minimum and roll down firmly and completely.

C. Double-cover inside and outside corners with membrane by applying initial strip of minimum 12-inch width centered along axis of corner. Mortar inside corners; round outside corners.

D. Double-cover construction and control joints with membrane. Apply double thickness of membrane over sealed expansion joints.

E. Provide troweled bead of asphaltic mastic as recommended by membrane manufacturer to perimeter of membrane placed in each day's operation and to outside edges of membrane after the membrane is placed.

F. At areas around drains, posts and other protrusions, install double layer of membrane and coat liberally with asphaltic mastic.

G. Immediately before covering membrane, inspect carefully and patch holes, tears, misaligned or wrinkled seams and other discontinuities with membrane or mastic. Conduct 24-hour flood test with minimum two-inch head of water on horizontal areas. Repair leaks, using methods recommended by membrane manufacturer.

H. Place specified protection material on membrane within five days after application. Apply material in accordance with manufacturer's written instructions, as shown and as specified.

3.05 PROTECTION OF WATERPROOFED SURFACES:

A. Install protection courses as soon as practicable after waterproofing is placed. Do not place loads on exposed membrane waterproofing. Traffic on such exposed membrane waterproofing is prohibited.

B. Provide temporary protection as required pending installation of permanent protection.

C. Exercise care in placing protection courses against waterproofing so as not to break, tear, puncture or otherwise damage waterproofing.

D. Provide protection of waterproofing surfaces as shown and as specified.
   1. Concrete: Place concrete protection courses in accordance with the applicable requirements of Section 03300 and as shown.
   2. Concrete blocks and common brick: Lay concrete blocks and common brick in portland-cement mortar, as shown and in accordance with the related work sections
   3. Concrete plank: Erect concrete plank with tight tongue-and-groove joints as shown.
   4. Insulation board:
      a. Apply protection-board adhesive in accordance with the manufacturer's instructions.
      b. Fit boards carefully and neatly around pipes and projections and cover up entire surface of waterproofing.
   5. Protection board: Affix protection board to membrane surface by butting and taping or lapping and taping in accordance with manufacturer's written instructions and as approved.
   6. Backfill: At depths of 10 feet or more from top of structure, excluding reliefs, place layer of sand 12 inches thick over membrane as approved.

3.06 REPAIR OF LEAKS:

A. Repair areas of concrete which leak, including cracks and other defective areas, and areas where membrane is inaccessible by using injected waterproofing or by repair methods that provide an impervious and watertight envelope around affected areas. Use epoxy-injection method.
   1. Epoxy injection:
      a. Commence epoxy-injection work after embankment or other backfill and waterproofing membrane have been placed to full required height on structure and for minimum distance of thirty feet beyond extent of repair area.
      b. Install injection work from interior side of repair areas by port-to-port method. Port spacing: Approximately 1-1/2 times thickness of receiving concrete section.
      c. Preseal intermediate joints to prevent escape of epoxy and complete each repair area for its entire length before commencing work in another area.
      d. Before proceeding, sweep space in vicinity of joint or crack receiving epoxy and leave in a generally clean condition. Remove dirt, laitance and other loose material from areas receiving epoxy by means of compressed-air jet.
      e. At joints and cracks, complete in order floors, walls and ceilings. Proceed with work from port-to-port, beginning at one end of joint. Inject epoxy by means of small nozzle held tightly against port. Continue operation until material begins to exude from next port. Repeat operations from port-to-port until entire area has been treated in one continuous operation. Seal ports as necessary to prevent drips or runout.
      f. Remove ports and finish surface of joints and cracks flush with adjacent concrete surfaces leaving no indentations or evidence of port fittings. Point joint surfaces and remove excess material from adjacent surfaces as necessary to leave joint smooth.

g. Equip injection pumps with device to positively indicate failure to pump in proper proportions, as well as bypass valves and gauges compatible with pump.

h. The Engineer may take cores at any location for inspection and testing. When it is determined that epoxy material has not penetrated to sufficient depth or is otherwise unsatisfactory, costs of coring and testing are the responsibility of the Contractor; where tests demonstrate that work is not substandard, costs of coring and testing will be paid by the Authority.

i. When cores demonstrate that epoxy has penetrated less than 90 percent of crack volume within core, work will be considered defective. Repair defective work by refilling cracks at such locations to achieve at least 90-percent penetration.

END OF SECTION

SECTION 07137

TUNNEL WATERPROOFING
(Two-Pass System)

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing a permanent waterproofing system and associated construction drainage between the initial and the final linings.

B. Related Work Specified Elsewhere:
1. Subway drainage: Section 02625.
2. Earth tunneling: Section 02415.
3. Precast concrete tunnel lining: Section 02425.
4. Cast-in-place concrete: Section 03300.
5. Miscellaneous metal: Section 05500.

C. Definitions:
1. Waterproofing: Geomembrane and geotextile installed around the entire circumference of the tunnel (invert and arch) between initial and final linings.
2. Geotextile: Geofabric providing groundwater drainage channel and protection of the geomembrane from sharp object projections of the initial lining.
3. Geomembrane: Synthetic membrane specifically formulated for waterproofing tunnel structure against groundwater pressure.
4. Invert drain: Temporary invert drain pipe
5. Water barrier: Water barriers installed around the entire circumference of tunnel where indicated.
6. Geo-drain filter fabric: Installed at weep holes where indicated.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. ASTM: A276, D257, D374, D638, D746, D751, D1777, D2136, D3776, D3787, D4491, D4533, D4632, D4716.
3. NFPA: 701.

B. Manufacturer's Qualifications:
1. Select a manufacturer who is regularly engaged in the production of similar geomembranes, geotextiles and water barriers.

C. Supervision and Training:
1. Have manufacturer's representative present during first 10 working days of installation.
2. Execute installation testing under direct supervision of an individual with recent, continuous and successful experience in the installation of tunnel membrane linings.
3. Provide personnel involved in lining installation and testing with training prior to beginning lining installation.

D. Membrane Protection:
1. Provide method and material to detect damage to geomembrane from final lining reinforcement placement.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with additional requirements as specified for each:

1. Material Samples:
   a. Geomembrane: One square foot.
   b. Double welded seam: One foot long.
   c. Geotextile: One square foot.
   d. Membrane attachment system: Two.
   e. Water barrier: One foot long, welded to geomembrane.
   f. Geo-drain filter fabric: One square foot.

2. Manufacturer's Installation Recommendations:
   a. Storage.
   b. Handling.
   c. Installation.
   d. Seaming.
   e. Attachment.
   f. Testing.
   g. Repair instructions.
   h. Special instructions for corners and intersections.
   i. Installation equipment.
   j. Damage detection method.

3. Manufacturer and Installer Qualifications:
   a. Evidence of manufacturer and installation qualifications.
   b. Resume of lining installation supervisors.

4. Certification of compliance with the requirements of this specification.

5. Shop drawings, including as a minimum the following:
   a. Sheet layout of geomembrane detailing seams.
   b. Details of seams, form bulkhead protection, attachment assembly for embedded lining items and other construction details.
   c. Water barrier and geo-drain filter fabrics locations and details attachment.

6. Working drawings including sequence of installation and details of invert drain support.

1.04 JOB CONDITIONS:

A. Install waterproofing only after acceptance of initial lining.

B. Replace or repair sections of the waterproofing membrane determined to be defective in accordance with geomembrane seam testing or visual inspection.

PART 2 - PRODUCTS

1.01 2.01 MATERIALS:

A. Geotextile:
   1. Non-woven, needle punched, 100 percent polypropylene geotextile of uniform thickness and surface texture.
   2. Minimum Physical Properties:

Property	Testing Method	Minimum Specifications
Thickness (mils)	ASTM D1777	285
Unit Weight (oz../sq. yd.)	ASTM D3776	22
Grab Strength (lbs.)	ASTM D4632	285/340
Elongation (percent)	ASTM D4632	85
Trapezoidal Tear (lbs.)	ASTM D4533	135/155
Burst Strength (psi)	ASTM D3787	400
In-Plane Flow Rate (gpm/ft. width)	ASTM D4716	0.04
pH Range	—	2 to 13

B. Geomembrane:

1. General: Plasticized PVC (PVC-P) waterproofing membrane of uniform surface texture reinforced with woven reinforcing fabric of glass felt.
2. Physical Properties:

Property	Testing Method	Minimum Specifications
Thickness (inch)	ASTM D751	
Invert		0.118
Arch		0.079
Ultimate Tensile Strength (lbs./sq. in.)	ASTM D638	2000
Ultimate Elongation (percentage)	ASTM D638	
glass-felt-reinforced membrane		200
woven-fabric-reinforced membrane		25
Flammability	NFPA 701	Self Extinguishing
Dielectric Strength (volts/mil.)	ASTM D257	440 to 462
pH Range	—	2 to 13

Property	Testing Method	Minimum Specifications
Low Temperature Bend	ASTM D2136	Pass at minus 40F
Woven Reinforcing Fabric (oz./sq. yd.)	—	13 for woven-fabric-reinforced membrane

C. Invert Drain:
   1. PVC pipe: Section 02625.
   2. Support: Manufactured of PVC compatible materials.

D. Attachments: Manufactured of PVC compatible materials, with recess for metal washers and nail.

E. Water Barriers:
   1. Base seal type water barrier with 6 rib minimum configuration, 1-1/2 inches minimum height, minimum 16 inches wide, manufactured from polyvinyl-chloride plastic compound, compatible with geomembrane.

   2. Physical Properties:

Property	Testing Method	Minimum Specifications
Thickness (inch)	ASTM D374	0.125
Ultimate Tensile Strength (lbs./sq. in.)	ASTM D638	2000
Ultimate Elongation (percent)	ASTM D638	300
Low Temperature Impact	ASTM D746	Pass at minus 20F

F. Geo-Drain Filter Fabric:
   1. BML Enterprises' B-Drain 60 or AKZO Industrial Systems Co.'s Enkadrain Type 9120 or approved equal.
   2. Physical Properties:

Property	Testing Method	Minimum Specifications
Tensile Strength (lbs.)	ASTM D4632	100
Weight (oz./sq.yd.)	ASTM D3776	4.0
Water Flow Rate (gpm/sq. yd.)	ASTM D4491	160

G. Sponge Rubber: Neoprene, closed cell, minimum 1/4-inch thick, as approved by PVC membrane waterproofing manufacturer.

H. Neoprene Adhesive: As approved by PVC membrane waterproofing manufacturer.

I. Batten Plates: Stainless steel, ASTM A276.

J. Expansion Anchor Bolts: Section 05500, hot-dip galvanized.

K. Nonshrink Grout: Section 03300.

PART 3 - EXECUTION

3.01 INITIAL LINING PREPARATION:

A. Repair damaged or spalled areas having a depth of greater than one inch.

B. Patch or plug recesses left from temporary supports of greater than 1-1/2 inches in diameter or least dimension, installed in initial lining for construction purposes.

C. Where surface offsets between initial liners exceeds 2-1/2 inches, place cement mortar or bush hammer to provide for a smooth transition from one lining to the next.

D. Remove sharp points and protrusions.

3.02 INVERT DRAIN: Install as shown.

3.03 DRAINAGE FABRIC AND SYNTHETIC MEMBRANE:

A. Installation sequence:
   1. Installation of geotextile with attachment assembly.
   2. Welding of geomembrane of attachments.
   3. Welding of seams.
   4. Testing.
   5. Installation of water barrier and filter fabric.
   6. Testing.

B. Attachment of geotextile membrane:
   1. Place attachment assemblies to achieve snug fit of geotextile membrane.
   2. Provide minimum of two attachments for 10 square feet of waterproofing in the arch and one attachment per 10 square feet in the invert.
   3. Provide additional attachments if required to provide support and fit to initial lining.

C. Provide sufficient scaffolding to allow inspection of installation.

D. Overlap materials minimum of three inches to form seams

E. Use radial seams in typical cross-sections unless otherwise approved.

F. Provide double seams unless single seams are approved.

G. Provide second layer of geomembrane welded over single seams. Second layer to completely cover single seams.

H. Where reinforcement is shown, use approved method to detect damage to geomembrane.

I. Provide attachment for reinforcement without penetration of the geomembrane.

J. Ensure flush contact between reinforcement spacers and geomembrane.

K. Provide minimum 1-1/2 inch clearance between items embedded in final lining and geomembrane, except grout pipes.

L. After the initial cast-in-place liner has cured, cap the drain pipe.

M. Provide attachment of water barriers at final cast-in-place liner construction joints at locations shown.

N. Provide attachment of geo-drain filter fabric at weep hole locations.

3.04 GEOMEMBRANE SEAM TESTING:

A. General:
1. Perform tests in presence of Engineer
2. Perform tests as installation progresses. Before installation continues, repair and retest seams that fail tests.
3. Maintain written record for test results, repairs, and retesting.

B. Double Seams:
1. Test by applying internal air pressure between seams.
2. Test at 30 psi for 10 minutes.
3. Reject seam if pressure falls below 27 psi.

C. Single Seams (repairs and circular tunnel-structure interface only):
1. Perform visual inspection while running a rounded screwdriver or similar tool along the joint after the weld has cooled.

D. Water Barrier Welds: Spark test weld for capability of maintaining dielectric integrity at 2,500 volts minimum.
1. Directly behind each single weld between water barrier and membrane, insert one 18 gauge bare copper wire for testing.
2. Test the full length of the water barrier weld unless directed otherwise by the Engineer.
3. Document the welds tested and the number of defects repaired. Provide documentation to the Engineer.

E. Replace or repair sections of the membrane determined to be defective at no additional cost to the Authority.

END OF SECTION

SECTION 07138

TUNNEL WATERPROOFING
(NATM SYSTEM)

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies furnishing and installing the permanent waterproofing system for the NATM tunnels installed between the shotcrete and the cast-in-place concrete linings.

B. Related Work Specified Elsewhere:
1. Subway drainage system: Section 02625.
2. Earth tunneling: Section 02416.
3. NATM excavation: Section 02417.
4. NATM shotcrete lining: Section 02426.
5. Cast-in-place concrete: Section 03300.
6. NATM concrete lining: Section 02427.

C. Definitions:
1. Tunnel waterproofing: Layered system of geomembrane and geotextile installed around the entire circumference of the tunnel between shotcrete and cast-in-place concrete linings to prevent intrusion of groundwater into the interior of the finished structure.
2. Geotextile: Fabric providing protection of the synthetic membrane from sharp projections of the shotcrete surface to which the membrane is applied.
3. Geomembrane: Synthetic waterproofing membrane specifically formulated for sealing underground structures against intruding groundwater and forming an electrical insulative barrier.
4. Water barrier: Base seal waterstop welded to membrane.
5. Sectioning: Water barriers arranged to seal off individual membrane sections.
6. Weepholes: Pipes typically installed near water barrier intersections and invert to drain water in case of leakage. These pipes are also used for repair in case of leakage by remedial grouting.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. ASTM: D257, D374, D638, D1593, D1777, D1785, D3776, D3787, D4533, D4632.
3. NFPA: 701.

B. Manufacturer's Qualifications:

1. Select manufacturers who are regularly engaged in the production of similar materials for underground structures.

2. Supply and install only products specifically designed and manufactured for this type of work.

C. Supervision and Training:
1. Execute installation and testing under direct supervision of an individual with recent, continuous and successful experience in the installation of waterproofing systems for underground structures using membrane materials as specified.
2. Provide trained personnel for installation and testing operations. Ensure that the installer has a minimum of five years experience in the installation of flexible

membranes in underground waterproofing installations. Have installer demonstrate proficiency of each welder in the field for respective approval by the Engineer.

D. Demonstration Section: Before proceeding with waterproofing installation, completely seal a minimum 30-foot-long demonstration section using materials and methods to be used in the work in accordance with specified requirements.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with additional requirements as specified for each:

1. Shop Drawings: Include as a minimum:
   a. Sequence of waterproofing installation relative to construction sequence.
   b. Details of attachment assembly, connections to waterproofing of adjacent structures, break-out structures, waterproofing at penetrations.
   c. Layout of sectioning by water barriers including detailed location of weep holes.
   d. Type and method of membrane protection at termination of work.
   e. Sheet layout of membrane detailing locations and types of seams.
   f. Manufacturer's Installation Procedures for:
      1) Storage.
      2) Handling.
      3) Seaming.
      4) Attachment.
      5) Smooth surfaces.
      6) Testing.
      7) Installation equipment.
      8) Detection of physical damage.
      9) Methods of local repair.
      10) Special instructions for corners and intersections/interfaces.
      11) Sequencing of waterproofing installation relative to formwork and concrete placement.
      12) Methods and materials used for prevention and detection of damage to the membrane by the above and any other construction equipment and materials.

2. Samples:
   a. Geotextile: One square foot.
   b. Geomembrane: One square foot including double welded seam one foot long.
   c. Attachment assembly: Three pieces.
   d. Protective fabric: One square foot.
   e. Water barrier: One foot length welded to membrane.

3. Certifications:
   a. Certification of compliance with the requirements of this specification.
   b. Resume of waterproofing installation supervisor.

1.04 DELIVERY, STORAGE AND HANDLING:

A. Deliver materials and products in labeled packages. Store and handle in compliance with manufacturer's instructions, recommendations and material safety data sheets. Place material on a smooth surface free of rocks or other protrusions which may damage the material. Protect from damage from sunlight, weather, excessive temperatures and construction operations. Remove damaged materials from the site and dispose of in accordance with applicable regulations.

B. Store flammable materials in a cool, dry area distant from sparks and open flames.

1.05 JOB CONDITIONS:

A. Install waterproofing only after surfaces to which geomembrane and geotextile will be applied have been accepted by the waterproofing installer and the Engineer.

B. Provide sufficient access to allow for thorough inspection.

C. Repair sections of the waterproofing determined to be defective by testing or which have been damaged during or after installation at no additional cost to the Authority.

D. Prior to waterproofing installation, prove the absence of continuing and significant deflection or increase of stress.

E. Drain off water that may be trapped between waterproofing and shotcrete by means of perforated drain pipes or drain mattings.

1.06 WARRANTY:

Provide a warranty for the watertightness of the structure for two years beyond the final work completion date.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Geotextile: Non-woven polypropylene geotextile of uniform thickness and surface texture with the following minimum physical properties and testing methods:

Property	Testing Method	Minimum Specifications
Thickness (mils)	ASTM D1777	285
Unit Weight (oz./sq. yd.)	ASTM D3776	22
Grab Strength (lbs.)	ASTM D4632	285
Elongation (percent)	ASTM D4632	85
Trapezoidal Tear (lbs.)	ASTM D4533	35
Burst Strength (psi)	ASTM D3787	400
Chemical Resistance	—	pH value 2 to 13

B. Geomembrane: Polyvinyl chloride (PVC) waterproofing membrane of uniform thickness and surface texture. PVC membrane non-reinforced with the following minimum physical properties under respective testing methods:

Property	Testing Method	Minimum Specifications
Thickness (inch)	ASTM D374	0.079
Ultimate Tensile Strength (lbs./sq. in.)	ASTM D638	2,200
Ultimate Elongation (percentage)	ASTM D638	230
Low Temperature Impact	ASTM D1593	Pass at minus 20C
Chemical Resistance	—	pH value 2 to 13
Flammability	NFPA 701	Self Extinguishing
Dielectric Strength (volts/mil.)	ASTM D257	440 to 465
Dielectric Constant		
60 Hertz	—	3.4 to 3.5
10^6 Hertz	—	3.3 to 3.4
Power Factor		
60 Hertz	—	0.006 to 0.007
10^6 Hertz	—	0.030 to 0.040

C. Attachments: Membrane attachment disk manufactured of membrane-compatible materials with minimum three-inch diameter with one steel washer embedded in disk. Attachment of discs with minimum 1-1/4 inch nails.

D. Water Barriers: Continuous strip weldable to membrane with six embedment ribs of the following minimum dimensions: 15-inch minimum width, 1-1/2 inch minimum height. Intersections of water barriers pre-fabricated at workshop on site or by manufacturer.

E. Protective Concrete: Section 03300, minimum class 2,500 psi, thickness as shown.

F. Weepholes: Three-inch polyvinyl chloride (PVC) pipe schedule 40, ASTM D1785, length as shown.

G. Invert Drain:
1. PVC pipe: Section 02625.
2. Support: Manufactured of PVC-compatible materials.

PART 3 – EXECUTION

3.01 PREPARATION OF SURFACE:

A. Cut off and patch projecting portions of dowels flush with the face of the shotcrete surface and remove temporary supports and hangers installed in shotcrete lining for construction purposes.

B. Ensure that embedded elements of the shotcrete lining are covered by at least one inch of shotcrete prior to installing geotextile and sealing membrane.

C. General Smoothness Criteria: Earth Tunneling, Section 02416.

D. Apply leveling shotcrete to areas that do not conform with the above requirements. Apply shotcrete in accordance with Section 02426.

E. Remove loose soil and debris.

F. Repair damaged or spalled surfaces, voids and cracks having depths greater than one inch with shotcrete, quick setting grout, mortar or equal.

G. Apply four-inch shotcrete layer at support of excavation walls to which geomembrane and geotextile will be applied at transitions to cut-and-cover structures as shown.

H. Ensure that surfaces are free of oils, grease and gasolines.

3.02 GEOTEXTILE AND GEOMEMBRANE:

A. General Installation Sequence:
1. Install geotextile with attachments assembly.
2. Weld geomembrane to attachment assemblies.
3. Weld seams.
4. Test seams.

B. Installation Area:
1. Place geotextile and geomembrane so as to cover the whole waterproofing area as shown.
2. Use radial seams in typical tunnel cross sections unless otherwise directed.
3. Use longitudinal seams at lap between invert and arch section.

C. Attachment:
1. Place attachment assemblies in surface depressions to achieve tight fit of geotextile.
2. Provide minimum of four attachments per 10 square feet of waterproofing area.
3. Provide additional attachment where necessary to achieve secure support and snug fit to shotcrete lining.

D. Geomembrane:
1. Provide double hot-wedge welded seams unless otherwise approved.
2. Single Seams: Where single seams are required and approved, weld second layer of geomembrane to completely cover single seams unless otherwise approved.
3. Prior to placement of concrete, re-inspect membrane for possible damages or other detrimental effects to membrane, such as build-up of water behind the membrane, and perform remedial work as required.

E. Water Barriers and Weepholes:
1. Install weepholes as shown prior to concrete lining placement.
2. As approved, arrange exact location of weepholes. Following concreting, contact grouting and repair grouting, clean weepholes and grout pipes in roof by approved methods and ensure that pipes are in operating conditions.
3. Document at a minimum the following and submit to the Engineer in form of a table:
   a. Location of weepholes.
   b. Location of water barriers and size of selections.
   c. Date of pipe installation.
   d. Names and signatures of installer and supervisor of sectioning and weepholes.
   e. Date of concreting and contact grouting.
   f. Names of workers and supervisors for respective work.

3.03 INVERT DRAIN:

A. Install as shown.

3.04 CONCRETE REINFORCEMENT AND OTHER EMBEDDED ITEMS:

A. Where reinforcement is placed, use approved methods to detect damage of geomembrane due to installation of reinforcement.

B. Provide minimum of two inches of clearance between embedded items and geomembrane.

C. Ensure flush contact between reinforcement spacers and geomembrane.

3.05 TESTING OF GEOMEMBRANE SEAMS:

A. General:
   1. Perform tests in the presence of the Engineer.
   2. Perform tests as installation progresses. Repair and retest seams that failed before continuing installation.
   3. Maintain written records of test results, repairs and retesting.

B. Double Seams: Perform test by applying internal air pressure between seams as follows:
   1. Test Pressure: 30 psi.
   2. Performance Requirements: Air pressure loss less than 10 percent after 10 minutes.

C. Single Seams:
   1. Including heat welding to water barriers or special fittings
   2. Check welds for continuity be either of the following visual inspections:
      a. Run a rounded screwdriver along the joint after the weld has cooled.
      b. Blow stream of air under high pressure against the weld and observe opening of the weld. Re-weld and test any discontinuity.

D. Replace or repair sections of the membrane determined to be defective at no additional cost to the Authority.

3.06 LEAK REMEDIATION:

A. Monitor structure interior by regular inspection for water leakage until the final work completion date. Beyond this date the structure to be inspected by the Authority.

B. If water leakage exceeds minimum allowable limits as specified in the watertightness criteria in Section 03300, undertake remedial measures consisting of:
   1. Grouting through weepholes using suitable grouts, eg. Silangels, Dynagrout or equal within the area of sectioning.
   2. Prior to beginning grouting work, submit grouting plan procedure and sample of grouting materials for approval.
   3. Establish injection pressure by means of on-site demonstration. Do not exceed structural capacity of the structure.

C. Do not penetrate or puncture membrane, except for permanent purposes using proven watertightness techniques as approved.

END OF SECTION

SECTION 07165

METALLIC WATERPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing metallic waterproofing.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. ASTM: C33, C144, C150.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

   1. Shop Drawings:
      a. Include detailed mixing, application and curing procedures from the metallic-waterproofing compound manufacturer.
   2. Certification:
      a. Certification that materials furnished meet specified requirements and are compatible with each other.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver materials to the jobsite in their original unopened containers clearly labeled with manufacturer's name, brand designation, reference specification number, type and class, as applicable.

B. Store materials in approved dry area and protect from contact with soil and from exposure to the elements. Keep materials dry.

C. Handle materials so as to prevent breakage of containers and damage to products.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
   1. Application of metallic waterproofing when ambient temperature is below 50F is prohibited.
   2. Do not apply metallic waterproofing until surfaces to be treated are enclosed or protected from excessive temperature changes.
   3. Keep water level below surface being treated until completion of curing treatment.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Portland Cement: ASTM C150, Type I.

B. Sand Aggregate: ASTM C144 for brush coat; ASTM C33 for protective coat.

C. Water: Potable.

D. Metallic Waterproofing Compound: Pulverized iron consisting of not less than 85 percent by weight of metallic aggregate with iron-oxide content not exceeding five percent by weight of iron, and chemical oxidizing agent within minimum of three percent and maximum of five percent by weight of compound.
1. Compound free of oil, paraffin, bitumen and other foreign substances.
2. Gradation requirements for iron particles:

Sieve Size	Percent Passing By Weight
20	100
30	95 to 100
40	90 to 100
60	65 to 100
100	45 to 70
200	10 to 25

PART 3 - EXECUTION

3.01 PREPARATION:

A. Wire brush surfaces to receive metallic-waterproofing treatment down to firm unspalled surfaces; ensure that surfaces are clean and free from loose materials, debris and deleterious substances such as oil and grease.

B. Strip and clean construction joints, grooved recesses and intersections of vertical and horizontal surfaces; remove loose material.

C. Install anchorage items prior to application of waterproofing. Except for anchorage items, obtain approval for completed work prior to attachment of utilities to waterproofed surfaces.

3.02 TEST AREA:

A. Prepare 100-square foot specimen of typical waterproofing application using specified methods and materials.

B. Location of test area as directed. Waterproofing will be visually and physically examined for bond and loose materials by the Engineer.

C. Failure of waterproofing to bond or appearance of excessive loose materials constitute grounds for rejection of proposed waterproofing materials and method of application. If test area is rejected, remove applied finish leaving base clean and acceptable for new application.

D. If necessitated by rejection of original test area, provide additional test areas. Do not proceed with waterproofing work until test area has been approved. Leave in place and open to observation as criteria for waterproofing work specified in this section.

3.03 APPLICATION:

A. Pack grooved recesses and intersections of vertical and horizontal surfaces with waterproofing mortar mixed in proportions of one-part portland cement to two parts sand aggregate, with 25 pounds of waterproofing compound added for each sack of cement. Do not use mortar that has been wet-mixed longer than 45 minutes.

B. Pack mortar into grooves and finish flush with adjacent surfaces. Finish internal angles to a 1/2-inch cove. Brush-coat construction joints with metallic-waterproofing mortar prior to placement of adjoining concrete.

C. Saturate surfaces, except cut-back or undercut walls, with water and apply a minimum total amount of 30 pounds for three brush-coats of metallic-waterproofing compound per 100 square feet of surface, mixed and applied in accordance with approved procedure.

D. Saturate cut-back or undercut walls, with water and apply bond coat of metallic-waterproofing compound and water. Fill walls flush and smooth with portland-cement mortar and metallic-waterproofing compound in proportion of ten pounds of compound to each sack of cement. Fill and patch in layers not exceeding 3/4-inch thickness, work into voids, compact and finish flush with adjacent surfaces.

E. Accomplish waterproofing work so that surface is uniformly oxidized.

F. After waterproofing vertical surfaces, apply minimum 3/8-inch thick protective coating consisting of one-part portland cement to two and one-half parts sand aggregate, directly over metallic-waterproofing treatment. Float protective coating to smooth level surface.

G. Moist-cure metallic waterproofing for seven days minimum in accordance with Section 03300.

3.04 PROTECTING AND CLEANING:

A. Protect finish work during application of waterproofing. Repair or replace damaged finish work as directed.

B. Remove spots and spattering of waterproofing from finish work and leave entire work area in a condition acceptable to the Engineer.

C. Remove all waterproofing rubbish from premises and leave spaces in broom-clean condition.

END OF SECTION

SECTION 07170

BENTONITE WATERPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing bentonite composite sheet membrane waterproofing and waterstop, including accessories and related items.

B. Related Work Specified Elsewhere:
   1. Cast-In-Place Structural Concrete: Section 03300.
   2. Cast-In-Place Architectural Concrete: Section 03331.
   3. Seals and Sealants: Section 07900.

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Samples:
      a. Three of each type of the following materials used in the work:
         1) Composite sheet membrane waterproofing: 12 inches square.
         2) Tapes: Two feet long.
         3) Fasteners: Sets of 12.
         4) Termination bar: Two feet long.
         5) Mastic: One pint container.
         6) Waterstop material: Two feet long.
         7) Granular bentonite: One pound container
         8) Polyethylene sheets: 12 inches square.
         9) Primer: One pint container.
         10) Protection board: 12 inches long.
   2. Manufacturer's Certification: Submit written certification, signed by the manufacturer or authorized representative, per the following requirements:
      a. Prior to the submittal of shop drawings, certify that the waterproofing materials are compatible with the groundwater and soil characteristics. Perform required groundwater and soil testing to confirm compatibility of materials at no additional cost to the Authority. A written report of acceptability or required modifications to the bentonite mix to suit the subsurface conditions is to be submitted by the manufacturer.
      b. Certify that the submitted shop drawings and installation instructions correctly describe the waterproofing system to be installed.
      c. Certify that the materials furnished are compatible with each other.
      d. Prior to installation, certify that the substrate is in an acceptable condition for membrane installation.
      e. At completion of the installation, certify that the materials used in the work were in accordance with these Specifications, and that they were installed in accordance with the material manufacturer's installation instructions and recommendations.
   3. Complete catalogue cuts for each bentonite material used in the work, including manufacturer's installation instructions and data sheets indicating tensile strength, elongation, puncture resistance, resistance to hydrostatic head, pliability, permability and water migration.
   4. Manufacturer's Field Report: Submit copies of project inspection reports confirming proper installation of waterproofing system.

5. Shop Drawings: Submit shop drawings, certified as reviewed and approved by the manufacturer, showing waterstop and waterproofing membrane details at penetrations in the membrane (for pipes, conduits, etc.), corners of structures, ends of the membrane, joints in the structure, and interfaces with adjacent structures. Indicate joint or termination detail conditions, and conditions of interface with other materials. Indicate the sequence of installation of the materials.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of jurisdictional authorities.
2. AASHTO: M171.
3. ASTM: C272, D146, D226, D412, D449, D543, D638, D751, D781, D1621, D1668, E96, E154.

B. Qualifications of Applicator:
1. Furnish evidence from manufacturer that the waterproofing applicator is a qualified applicator of the material to be applied.

C. Manufacturer
1. Obtain primary waterproofing materials of each type required from a single manufacturer. Provide secondary materials only as recommended by manufacturer of primary materials.
2. Arrange for waterproofing system manufacturer to inspect and approve the waterstop and waterproofing membrane installation and to provide job service at no additional cost to the Authority.
3. Make arrangements with the manufacturer to provide on-site consultation and inspection services to ensure the correct installation of the waterstop and waterproofing membrane at no additional cost to the Authority. Have the manufacturer monitor the waterstop and membrane installation on a full time basis during initial installation period, and at least once a week thereafter, until completion of the waterproofing work.
4. Have the manufacturer's representative present at the time any phase of the work is started. Apply waterstop and waterproofing membrane only over substrate previously approved by the manufacturer's representative and the Engineer.
5. Have the manufacturer's representative make periodic visits to the site as work proceeds as necessary for consultation and for expediting the work in the most practical manner.

D. Preinstallation Conference:
1. Prior to installation of waterproofing and associated work, meet at project site with waterproofing installer and installers of each component of associated work, including manufacturer's representatives and inspection personnel, to coordinate related requirements with waterproofing work. Review material selections and procedures to be followed in performing work. Perform a sample installation of each of the waterproofing materials. Notify Engineer at least 48 hours before conducting meeting.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to the job site in their original unopened containers clearly labeled with manufacturer's name, brand designation, type and class, as applicable.

B. Store products in approved dry area and protect from contact with soil and from exposure to elements. Keep products dry.

C. Handle products so as to prevent breakage of containers and damage to products.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
1. Application of waterproofing to surfaces on which ice or frost is visible is prohibited. Keep substrate free of ponded water.
2. Install and proceed with waterproofing and associated work only when existing and forecasted weather conditions will permit work performance in accordance with manufacturer's recommendations and warranty requirements for specific project requirements.

1.06 WARRANTY:

A. In addition to warranty requirements of the General Provisions, furnish a four-year warranty for a total of five years against defective materials and workmanship.

PART 2 – PRODUCTS

2.01 MATERIALS:

A. Polyethylene Sheet: AASHTO M171, clear, eight mils thick, reinforced.

B. Bentonite Composite Waterproofing Membrane:
1. Membrane: Multiple component sheet membrane composed of high density polyethylene (HDPE) laminated to bentonite that is coated with a protective layer of spun polypropylene or protected with high-strength woven geotextile. The membrane is to exhibit the following properties:

Property	Test Method	Result
Weight of Sodium Montmorillonite (Bentonite)		one pound per square foot minimum
Thickness of HDPE	—	20 mils
Total thickness of membrane	—	180 mils plus or minus 10 mils
Tensile strength	ASTM D412	4,000 psi
Ultimate elongation	ASTM D638, Type 4	700 percent
Puncture resistance	ASTM E154	160 pounds
Resistance to hydrostatic head; 150 feet of water	ASTM D751 Method A	Zero leakage
Pliability; 180 degree bend over one-inch mandrel at minus 25F; 10,000 cycles	ASTM D146	No cracks
Permeance	Membrane applied	2.7×10^{-13} cm/sec

	to porous stone and placed in permeameter. Pressure increased to equivalent of 150 foot water head.	
Chemical resistance	ASTM D543	No damage

C. Joint Tape:

1. Self-adhering, four-inch wide, minimum 60-mils thick, multi-purpose rubberized asphalt membrane, laminated to a polyethylene film reinforcing. Use for permanently sealing the seams. Compatible with the membrane system used.

Property	Test Method	Result
Tensile strength	ASTM D412C	250 psi
Elongation	ASTM D412C	350 percent
WVT at 80F	ASTM E96B	0.1 maximum gr/sq.ft./hr./in. Hg
Peel adhesion	—	Joint tape is applied over the seams of membrane. Wipe membrane clean and free from dust or moisture.
Pliability	ASTM E96b	Passes at minus 25F
Membrane	ASTM E154	40 pound minimum
Film	ASTM D781	250 inches per ounce
Burial (16 weeks)		unaffected
Hydrostatic head	—	150 feet minimum

D. Termination Bar:

1. Aluminum alloy bar, factory pre-punched, designed for use as termination bar, edge protector or caulk bar for membranes and systems specified.

E. Primer for Tapes and Waterstops:

1. Bonding agent for use as primer at concrete, masonry, metal and wood surfaces and as recommended by manufacturer.

F. Water Barrier Tape:

1. Tape consisting of a layer of bentonite, approximately 3/16-inch thick by one-inch, three-inches and six-inches wide, sandwiched between an open woven mesh and a spun bond polypropylene fabric, with one side coated with pressure sensitive adhesive and release paper.

G. Mastic:

1. Thick compound of expandable mastic containing not less than 55 percent high swelling, Wyoming-type sodium montmorillonite (bentonite) for use at voids, honeycombs, penetrations, tie-backs, cants and similar conditions.

H. Granular Bentonite:
   1. High quality, Wyoming-type, sodium montmorillonite (bentonite), similar to material used in membrane specified above, for use in forming coves and for filling voids during installation of waterproofing systems. Granular, high-swelling Wyoming-type bentonite weighing 60 pounds per cubic foot minimum, and capable of expanding a minimum of 10 times its apparent dry volume when added to water.
   2. Granule size: 90 percent minimum passing Size 20 mesh with less than five percent passing Size 200 mesh.

I. Bentonite Composition Waterstop:
   1. Multiple composite waterstop cube, one-inch wide by 3/4-inch high, of laminated sodium montmorillonite (bentonite) reinforced with two layers of polyester netting and non-woven polypropylene, with one side coated with pressure sensitive adhesive and release paper, or a bentonite and butyl rubber based waterstop.

J. Fasteners:
   1. Case hardened nails with enlarged head or caps to hold membrane.
   2. Head or cap to be one-inch in diameter, minimum.
   3. Fluted shank of appropriate length to fasten waterproofing membrane or joint seal.

K. Asphalt: ASTM D449, Type A.

L. Fibrous-Glass Membrane: ASTM D1668, Type I or III.

M. Asphalt-Saturated Felt: ASTM D226, Type I.

N. Protection Course Material:
   1. Mud slab and concrete protection course: Section 03300, Class 3500.
   2. Protection Board:
      a. Semi-flexible board, five-ply or more, composed of asphaltic core sealed under heat and pressure between two liners of asphalt-saturated kraft paper or felt, bonded to independent waterproofing during the manufacturing process. Thickness as recommended by manufacturer.
      b. Extruded, rigid polystyrene-foam board, one-inch thick. Compressive strength 25-psi minimum, ASTM D1621; water absorption 0.1 percent, ASTM C272.

O. Protection Board Adhesive: As recommended by the protection board manufacturer.

PART 3 – EXECUTION

3.01 INSPECTION:

A. General: Inspect surfaces to receive waterproofing membrane system. Ensure that voids greater than 3/8-inch are filled with grout or with mastic, and that sharp projections are removed.

B. Do not install membrane or system in standing water. Have accidental water accumulation pumped out and proper drainage ensured. Restore the bentonite waterproofing system if damage occurs. Comply with temperature limitations for each product.

C. Vacuum or broom clean surfaces to receive tape, adhesive products or primers. Ensure that such surfaces are free of dust, dirt, snow, ice and other contaminants not compatible with applied products.

3.02 PREPARATION:

A. Layout: Layout project to determine anticipated conditions prior to start of work. Note termination and penetration conditions and determine preferred methods for creating waterproof envelope.

B. Voids: Fill voids greater than 3/8-inch with mastic and remove sharp projections in substrate.

C. Coves: Form coves, one-inch to two-inches, with granular bentonite at intersections of walls and footings. Form coves with mastic at vertical inside corners, under ledges and at penetrations.

D. Priming: Prime surfaces immediately prior to application of tapes and waterstops with specified primer. Prime surfaces, including concrete, masonry, metal and wood, to properly prepare areas to receive waterstop, taped applications and terminations.

3.03 INSTALLATIONS:

A. General: Conform to manufacturer's installation instructions and the following: If the waterproofing membrane is damaged during installation, overlap the damaged area with another piece of waterproofing membrane, providing the minimum overlap around the damaged area per the manufacturer's recommendations. Fasten the overlap piece of membrane and seal along its edges per the manufacturer's recommendations.

B. Below Slab-On Grade:

1. Ensure that mud slab surfaces are level and prepared as specified above. Apply polyethylene slip sheet, minimum eight mils thick, with seams lapped minimum six inches prior to installing membrane.
2. Place membrane over prepared surfaces in such a manner as to ensure minimum handling. Fit material closely and seal around inlets, outlets and other projections. Follow installation procedures as recommended by membrane manufacturer.
3. Install membrane with HDPE side up with edges overlapped a minimum of six inches. Staple joints every eight inches on center and wipe joint surfaces clean and free of dirt, dust, moisture and other foreign material. Apply joint tape to joint areas and press together immediately. Compress membrane and joint sealant tape with roller using 10 psi nominal pressure. Remove wrinkles, holidays and fishmouths. Carefully inspect seams and reseal voids. Install only as much membrane as can be covered in one day.
4. Protect membrane from damage caused by rebar chairs with sharp edges and construction operations by placing three-inch concrete protection course, or per manufacturer's recommendation.
5. Pour granular bentonite, adhere water barrier tape or bentonite composite waterstop, and trowel mastic around penetrations as directed by the manufacturer. Place custom fitted collar of membrane as directed by the manufacturer.
6. Extend the waterproofing membrane 12 inches up or beyond the perimeter slab form. Use this excess material to overlap with wall waterproofing membrane.
7. Inspect and replace damaged waterproofing material before placing concrete.

C. Backfilled Walls:

1. General: Place membrane, with the HDPE side facing installer, over prepared surfaces, vertically and horizontally as applicable for conditions, to ensure minimum handling of products. Fit materials closely and seal around inlets, outlets and other

penetrations and projections. Comply with installation procedures as recommended by membrane manufacturer.

2. Field Joints: Install membrane shingle fashion to prevent intrusion of water. Overlap a minimum of six inches typically, depending on installation conditions.
   a. Vertical Seam Application: Nail at 24 inches to 48 inches on center as recommended by manufacturer for conditions indicated. Tape seams with joint tape.
   b. Horizontal Seam Applications: Nail at 18 inches on center, maximum. Tape seams with joint tape as specified above.
3. Penetrations: Prior to pouring the wall concrete, wrap water barrier tape or bentonite composite waterstop around the pipe or sleeve within the wall area as recommended by the manufacturer. Cut membrane to fit snugly at penetration. Form cove around penetrations with specified mastic. Provide site fabricated collar made from waterproofing membrane to fit tightly around penetration and press firmly to embed fully in mastic. Fasten collar and tape in place.
4. Termination: Terminate membrane applications as shown and as follows:
   a. Install membrane into reglet as shown and fasten termination bar at top of membrane. Position to properly apply elastometric sealant, specified in Section 07900, Seals and Sealants. Space fasteners as eight inches on center. Confirm suitability of substrate to accept fasteners.
   b. Protect membrane from damage by placing protection board against the membrane prior to backfilling operations in accordance with manufacturer's recommendations.

D. Underground Roof Slabs:
1. General: Place membrane over prepared surfaces in such a manner as to ensure minimum handling. Fit closely and seal around inlets, outlets and other penetrations and projections. Follow installation procedures as recommended by membrane manufacturer.
2. Install membrane with bentonite side down, facing roof slab, in shingle fashion. Start installation at lowest point.
3. Field Joints: Provide lapped and sealed joints in field using joint tape. Form lapped joints by lapping edges a nominal six inches, unless larger overlap is recommended by membrane manufacturer. Wipe contact surfaces of pieces clean and free of dust, dirt, moisture and other foreign materials. Apply joint tape to joint area and press together immediately. Compress membrane and joint tape with roller using 10 psi nominal pressure. Remove wrinkles, holidays and fishmouths. Carefully inspect seams and reseal voids.
4. Penetrations: Prior to pouring the roof concrete, wrap water barrier tape or bentonite composite waterstop around the pipe or sleeve within the slab area as recommended by the manufacturer. Install membrane around penetrations. Liberally apply mastic or granular bentonite around penetration. Install site fabricated collar, made from waterproofing membrane, fit tightly around penetration and tape in place.
5. Transitions and Terminations: Comply with manufacturer's instructions for conditions, applications, transitions and terminations.
6. Protect membrane from damage by placing three inch concrete protection course.

E. Lagging and Shoring Applications:
1. General: Place membrane over prepared surfaces in such a manner as to ensure minimum handling. Fit closely and seal around inlets, outlets and other projections. Cover openings larger than one inch with minimum 1/4-inch thick plywood, or fill with grout. Follow installation procedures as recommended by membrane manufacturer.
2. Membrane Installation: Install membrane as directed by manufacturer, with bentonite surface facing installer. When installed, prior to placement of concrete against the bentonite face, secure membrane and accessories to prevent

displacement or damage. Start installation at low point and install shingle fashion to prevent instruction of water with minimum 12 inches overlap. Install nails only at seams as described above under Backfilled Walls. Apply mastic over the nail heads and staples. Close fishmouths, blousing and holidays with staple hammer at four inches on center.

3. Penetrations: Trowel apply mastic at penetrations and other locations to provide a complete and proper waterproofing envelope. Furnish and install site fabricated collar made from waterproofing membrane to fit tightly around penetration and press firmly to embed fully in mastic. Fasten collar in place. Wrap water barrier tape or bentonite composite waterstop around pipe or sleeve within the wall area prior to pouring the concrete, as recommended by the manufacturer.
   a. At special conditions, including but not limited to soldier piles and beams, construction joints, pipe penetrations and other conditions, based on manufacturer's printed product data, apply water barrier tape.
4. Transitions and Terminations: Comply with the manufacturer's specific instructions for special conditions, applications, transitions and terminations.
5. After membrane installation, drape polyethylene sheets with seams lapped a minimum of six inches over membrane and fasten securely. Immediately before or concurrently with placement of concrete, remove sheets, exposing membrane.

F. Joints:
1. Waterproof contraction and construction joints at exterior walls and slabs using PVC waterstop, composite bentonite or bentonite composite water barrier tape as shown.
2. Trowel smooth the joint surfaces where bentonite composite waterstop is to be installed. If the surface becomes roughened during the preparation of a bonded joint per Section 03300, install mastic prior to installing the bentonite composite waterstop.
3. Install primer and nail bentonite composite waterstop in place at 12 inches on center as recommended by the manufacturer.
4. Do not install bentonite composite waterstop in wet conditions except as recommended by the manufacturer.

3.04 PROTECTION OF WATERPROOFED SURFACES:

A. Install protection course as soon as practicable after waterproofing membrane is placed. Do not place loads on exposed waterproofing membrane. Traffic on exposed waterproofing membrane is prohibited.

B. Provide temporary protection as required pending installation of permanent protection.

C. Exercise care in placing protection course against waterproofing membrane so as not to break, tear, puncture or otherwise damage waterproofing membrane.

D. Protect waterproofing surfaces as shown and with the following:
1. Concrete: Place concrete protection course and mud slab in accordance with the applicable requirements of Section 03300 and as shown.
   a. Protection Board: Affix protection board to membrane surface by butting and taping, or lapping and taping, in accordance with manufacturer's written instructions and as approved.

3.05 REPAIR OF LEAKS:

A. Repair leak areas by means of a bentonite slurry, epoxy injection or both methods to provide impervious and watertight envelope around affected areas.

B. Pump bentonite slurry toward outside of structure through drilled holes, at a pressure not exceeding 50 psi, to create waterproof layer.

C. Submit repair schedule and methods for approval before proceeding with work.

END OF SECTION

SECTION 07180

TRAFFIC COATINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This Section includes traffic coatings for the following applications:
   1. Vehicular traffic.

B. Related Sections include the following:
   1. Structural Precast Concrete - Section 03331

1.02 SUBMITTALS

A. Product Data: For each product indicated.

B. Shop Drawings: Show extent of each traffic coating. Include details for treating substrate joints and cracks, flashings, deck penetrations, and other termination conditions. Include layout of traffic striping and markings.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors, textures, and patterns available for each type of product indicated.

D. Samples for Verification: For each type of traffic coating required, prepared on rigid backing and of same thickness and material indicated for the Work.
   1. Provide stepped samples on backing large enough to illustrate build-up of traffic coatings.

E. Material Certificates: Signed by manufacturer certifying that traffic coatings comply with requirements, based on comprehensive testing of current product formulations within the last three years.

F. Maintenance Data: To include in maintenance manuals specified in Division 1. Identify substrates and types of traffic coatings applied. Include recommendations for periodic inspections, cleaning, care, maintenance, and repair of traffic coatings.

1.03 QUALITY ASSURANCE

A. Installer (Applicator) Qualifications: An experienced applicator who has specialized in installing work similar in material, design, and extent to that indicated for this Project and who is acceptable to manufacturer.

B. Source Limitations: As follows:
   1. Use traffic coatings of a single manufacturer.
   2. Obtain primary traffic coating materials, including primers, from traffic coating manufacturer. Obtain secondary materials including aggregates, sheet flashings, joint sealants, and substrate repair materials of type and from source recommended by traffic coating manufacturer.

C. Fire-Test-Response Characteristics: For traffic coatings as follows:
   1. Fire-response testing was performed by UL, ITS, or another independent testing and inspecting agency that is acceptable to authorities having jurisdiction and that performs testing and follow-up services.

2. Provide materials identical to those of traffic coatings tested according to ASTM E 108 for deck type and slopes indicated and that comply with requirements for roof-covering Class indicated.

D. Mockups: The Engineer will select one representative surface for each traffic coating and each substrate to receive traffic coatings. Apply each coating to at least 200 sq. ft.20 sq. m of each substrate to demonstrate surface preparation, joint and crack treatment, thickness, texture, color, and standard of workmanship.
1. Remove and reapply mockups until they are approved by The Engineer.
2. Keep approved mockups undisturbed during construction as a standard for judging completed traffic coatings. Undamaged mockups may be incorporated into the Work.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers with seals unbroken and bearing manufacturer's labels showing the following information:
1. Manufacturer's brand name.
2. Type of material.
3. Directions for storage.
4. Date of manufacture and shelf life.
5. Lot or batch number.
6. Mixing and application instructions.
7. Color.

B. Store materials in a clean, dry location protected from exposure to direct sunlight. In storage areas, maintain environmental conditions within range recommended in writing by manufacturer.

1.05 PROJECT CONDITIONS

A. Environmental Limitations: Apply traffic coatings within the range of ambient and substrate temperatures recommended in writing by manufacturer. Do not apply traffic coatings to damp or wet substrates, when temperatures are below 40 deg F5 deg C, when relative humidity exceeds 85 percent, or when temperatures are less than 5 deg F3 deg C above dew point.
1. Do not apply traffic coatings in snow, rain, fog, or mist, or when such weather conditions are imminent during the application and curing period. Apply only when frost-free conditions occur throughout the depth of the substrate.

1.06 WARRANTY

A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

B. Special Warranty: Written warranty, signed by traffic coating manufacturer agreeing to repair or replace traffic coatings that do not comply with requirements or that deteriorate during the specified warranty period. Warranty does not include deterioration or failure of traffic coating due to unusual weather phenomena, failure of prepared and treated substrate, formation of new substrate cracks exceeding 1/16 inch1.6 mm in width, fire, vandalism, or abuse by snowplow, maintenance equipment, and truck traffic.
1. Deterioration of traffic coatings includes, but is not limited to, the following:
a. Adhesive or cohesive failures.
b. Abrasion or tearing failures.

c. Surface crazing or spalling.
d. Intrusion of water, oils, gasoline, grease, salt, deicer chemicals, or acids into deck substrate.

C. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Physical Requirements: Provide traffic coatings complying with ASTM C 957.

B. Material Compatibility: Provide primers; base, intermediate, and top coats; and miscellaneous materials that are compatible with one another and with substrate under conditions of service and application, as demonstrated by the manufacturer based on testing and field experience.

2.02 TRAFFIC COATING

A. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
1. Dura-Deck 800V ; Pecora Corporation.

B. Primer: Manufacturer's standard factory-formulated primer recommended for substrate and conditions indicated.

C. Preparatory and Base Coats: Single- or multicomponent aromatic liquid urethane elastomer.

D. Intermediate Coat: Single- or multicomponent aromatic liquid urethane elastomer.

E. Top Coat: Single- or multicomponent aromatic liquid urethane elastomer.
1. Color: As selected by The Engineer from manufacturer's full range.

F. Component Coat Thicknesses: As recommended by manufacturer for substrate and service conditions indicated.

G. Aggregate: Uniformly graded washed silica sand of particle sizes, shape, and minimum hardness recommended in writing by traffic coating manufacturer.
1. Spreading Rate: As recommended by manufacturer for substrate and service conditions indicated.
a. Top Coat: As required to achieve slip-resistant finish.

H. Fire-Test-Response Characteristics: Class A roof covering per ASTM E 108.

2.03 MISCELLANEOUS MATERIALS

A. Sheet Flashing: Sheet material recommended by manufacturer.

B. Adhesive: Manufacturer's recommended contact adhesive.

C. Reinforcing Strip: Manufacturer's recommended fiberglass mesh.

D. Traffic Paint: Alkyd-resin ready mixed, complying with AASHTO M 248.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine substrates, with Applicator present, for compliance with requirements and for other conditions affecting performance of traffic coatings.
   1. For the record, prepare written report, endorsed by Applicator, listing conditions detrimental to performance.
   2. Verify compatibility with and suitability of substrates.
   3. Begin coating application only after minimum concrete curing and drying period recommended by traffic coating manufacturer has passed, after unsatisfactory conditions have been corrected, and after surfaces are dry.
   4. Verify that substrates are visibly dry and free of moisture. Test for moisture by method recommended in writing by manufacturer.
   5. Application of coating indicates acceptance of surfaces and conditions.

3.02 PREPARATION

A. Clean and prepare substrates according to manufacturer's written recommendations to produce clean, dust-free, dry substrate for traffic coating application.

B. Mask adjoining surfaces not receiving traffic coatings, deck drains, and other deck substrate penetrations to prevent spillage, leaking, and migration of coatings.

C. Concrete Substrates: Mechanically abrade concrete surfaces to a uniform profile according to ASTM D 4259. Do not acid etch.
   1. Remove grease, oil, paints, and other penetrating contaminants from concrete.
   2. Remove concrete fins, ridges, and other projections.
   3. Remove laitance, glaze, efflorescence, curing compounds, concrete hardeners, form-release agents, and other incompatible materials that might affect coating adhesion.
   4. Remove remaining loose material to provide a sound surface, and clean surfaces according to ASTM D 4258.

3.03 TERMINATIONS AND PENETRATIONS

A. Prepare vertical and horizontal surfaces at terminations and penetrations through traffic coatings and at expansion joints, drains, and sleeves according to ASTM C 1127 and manufacturer's written recommendations.

B. Provide sealant cants at penetrations and at reinforced and nonreinforced deck-to-wall butt joints.

C. Terminate edges of deck-to-deck expansion joints with preparatory base-coat strip.

D. Install sheet flashings at deck-to-wall expansion and dynamic joints, and bond to deck and wall substrates according to manufacturer's written recommendations.

3.04 JOINT AND CRACK TREATMENT

A. Prepare, treat, rout, and fill joints and cracks in substrates according to ASTM C 1127 and traffic coating manufacturer's written recommendations. Before coating surfaces, remove dust and dirt from joints and cracks according to ASTM D 4258.
   1. Comply with recommendations in ASTM C 1193 for joint-sealant installation.

3.05 TRAFFIC COATING APPLICATION

A. Apply traffic coating material according to ASTM C 1127 and manufacturer's written recommendations.
   1. Start traffic coating application in presence of manufacturer's technical representative.
   2. Verify that wet film thickness of each component coat complies with requirements every 100 sq. ft9 sq. m.
   3. Apply traffic coatings to prepared wall terminations and vertical surfaces to height indicated and omit aggregate on vertical surfaces.

B. Apply traffic paint for striping and other markings with mechanical equipment to produce uniform straight edges. Apply at manufacturer's recommended rates for a 15-mil0.38-mm minimum wet film thickness.

END OF SECTION

SECTION 07210

BUILDING INSULATION

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing building insulation.

B. Related Work Specified Elsewhere:
   1. Wood preservation treatment: Section 06075.
   2. Built-Up Roofing: Section 07515.
   3. Flashing and Sheet Metal: Section 07600.

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Include manufacturer's material, handling, adhesive-mixing and application instructions for each type of product used in the work.
      b. Woodnailers, cant strips.
      c. Each tapered and flat roof insulation system.
         1) Show location and spacing of wood nailers and cants that are required for securing insulation and for back nailing of roofing felts. Show a complete description for he procedures for the installation of each phase of the system indicating the type of materials thicknesses, identity codes, sequence of laying insulation, special methods for cutting and fitting of insulation, and special precautions. The drawings shall be based on installation of the insulation in conjunction with the roofing system specified in Section 07515.
   2. Samples:
      a. Three of each type of the following materials used in the work:
         1) Insulation: 12- inch square units; pint container for loose fill.
         2) Adhesive: Pint containers.
         3) Fasteners: Six of each type.
         4) Asphalt: Pint containers.
         5) Vapor Barrier: 12 inches square.
         6) Cant strip: 12 inches long.
   3. Certification:
      a. Submit certification from manufacturer of insulation verifying that insulation applicator is approved by manufacturer, and has successfully performed at least three satisfactory insulation installations using methods and materials similar to those specified.
      b. Certification that materials furnished meet specified requirements and are compatible with each other.
   4. Test Reports:
      a. Submit flame spread and smoke developed ratings in accordance with ASTM E84.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:

SECTION 07411

SHEET METAL ROOFING SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies preformed, prefinished standing seam and flat seam metal roofing, metal fascia panels, flashing, and accessories.

B. Related Work Specified Elsewhere:
1. Metal Decking: Section 05310.
2. Flashing and Sheet Metal: Section 07600.
3. Roof Accessories: 07730.
4. Seals and Sealants: 07900.

1.02 PERFORMANCE REQUIREMENTS:

A. Install sheet metal roofing capable of withstanding normal thermal movement, wind loading, structural movement, thermally induced movement, and exposure to weather without failure or infiltration of water into the building interior or through the canopy structure.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements for approval and with the additional requirements as specified for each:

1. Product Data: For each product indicated.
   a. Submit product data indicating the metal roofing systems meet the specified requirements and indicating compliance with minimum specified ASTM and U.L. requirements.

2. Shop Drawings: Show details for forming, joining, and securing metal roofing, and for pattern of seams. Show expansion-joint details and waterproof connections to adjoining work and at obstructions and penetrations. Include details of construction relative to materials, dimensions of individual components, profiles, and finishes.
   a. Submit calculations with registered engineer seal, verifying roof panel and attachment method resists wind pressures imposed on it pursuant to applicable building codes.

3. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for metal roofing with color-coated finishes.

4. Samples for Verification: 12-inch- square specimens of metal roofing material with specified finishes applied. Where finishes involve normal color and texture variations, include Sample sets of 2 or more units showing the full range of variations expected.

5. Certifications.

1.04 QUALITY ASSURANCE:

A. Installer Qualifications: Engage an experienced installer who has completed sheet metal roofing similar in material, design, forming method, and extent to that indicated for this Project and with a record of successful in-service performance.

B. Select a Manufacturer specializing in Architectural Sheet Metal Products with five (5) years minimum experience.

C. Codes, regulations, Reference Standards and Specifications:
1. ASTM A653, A666, A775, B209, B370, C920, D 226, D523, D926, D4214, D1970E 699-99, E 1646 E 1680-95, E1592-98
2. SMACNA - Architectural Sheet Metal Manual.
3. CDA - Copper Development Association Handbook.
4. AAMA 1402.

D. General: Provide manufactured sheet metal roofing assemblies complying with performance requirements indicated and capable of withstanding structural movement, thermally induced movement, and exposure to weather without failure or infiltration of water into the building interior.
1. Air Infiltration: Provide manufactured roof panel assemblies with permanent resistance to air leakage through assembly of not more than 0.09 cfm/sq. ft. of fixed roof area when tested according to ASTM E 1680 at a static-air-pressure difference of 4.0 lbf/sq. ft.
2. Water Penetration: Provide manufactured roof panel assemblies with no water penetration as defined in the test method when tested according to ASTM E 1646 at a minimum differential pressure of 20 percent of inward acting, wind-load design pressure of not less than 6.24 lb/sq. ft. and not more than 12.0 lb/sq. ft.
3. Wind-Uplift Resistance: Provide roof panel assemblies that meet requirements of UL 580 for Class 90 wind-uplift resistance. Design Load: 90 m.p.h., basic wind load velocity.
4. Structural Performance: Provide manufactured roof panel assemblies capable of safely supporting design loads indicated under in-service conditions with vertical deflection no greater than the following, based on testing manufacturer's standard units according to ASTM E 1592 by a qualified independent testing and inspecting agency.
    a. Maximum Deflection: 1/140 of the span.
    b. Design Load: 30 p.s.f.

E. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where the Project is located and who is experienced in providing engineering services of the kind indicated.

F. Field Measurements: Verify location of structural members and openings in substrates by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, either establish opening dimensions and proceed with fabricating roof panels without field measurements or allow for trimming panel units. Coordinate roof construction to ensure actual locations of structural members and to ensure opening dimensions correspond to established dimensions.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver metal coils, panels, and other roofing materials so they will not be damaged or deformed. Package roofing materials for protection against transportation damage.

B. Handling: Exercise care in unloading, storing, and erecting roofing materials to prevent bending, warping, twisting, and surface damage.

C. Stack materials on platforms or pallets, covered with tarpaulins or other suitable weathertight and ventilated covering. Store metal roof coils and panels to ensure dryness. Do not store coils or panels in contact with other materials that might cause staining, denting, or other surface damage.

1.06 WARRANTY:

A. General Warranty: Special warranties specified in this Section shall not deprive the Authority of other rights the Authority may have under other provisions of the General Provisions and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Finish Warranty: Submit a written warranty executed by the manufacturer covering failure of the factory-applied exterior finish on metal roofing within the specified warranty period and agreeing to repair finish or replace sheet metal roofing that evidences finish deterioration. Deterioration of finish includes, but is not limited to, color fade, chalking, cracking, peeling, and loss of film integrity.
   1. Finish Warranty Period: Nineteen (19) year guarantee in addition to the warranty provisions of the General Provisions for at total of 20 years from date of Substantial Completion.

C. Special Weathertight Warranty: Submit a written warranty executed by the manufacturer agreeing to repair or replace sheet metal roofing that fails to remain weathertight within the specified warranty period.
   1. Weathertight Warranty Period: One year guarantee in addition to the warranty provisions of the General Provisions for at total of 2 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 ROOFING SHEET METALS:

A. Metallic-Coated Steel Sheet Prepainted with Coil Coating: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755ASTM A 755M and the following requirements:
   1. Galvanized Steel Sheet: ASTM A 653, G90 (ASTM A 653M, Z275); structural quality.
   2. Finish: Apply the following organic coating in a thickness of not less than 0.0336 inch, unless otherwise indicated. Furnish appropriate air-drying spray finish in matching color for touchup.
      a. Durability: Provide coating field tested under normal range of weather conditions for minimum of 20 years without significant peel, blister, flake, chip, crack, or check in finish; without chalking in excess of a chalk rating

of 8 according to ASTM D 4214; and without fading in excess of 5 Hunter units.

1) Fluoropolymer 2-Coat Coating System: Manufacturer's standard 2-coat, thermocured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight with a total minimum dry film thickness of 0.9 mil and 30 percent reflective gloss when tested according to ASTM D 523.

b. Color: As selected by Architect from manufacturer's full range of colors.

B. Aluminum Sheets: ASTM B 209 (ASTM B 209M) for Alclad alloy 3003 or 3004 with temper as required to suit forming operations and finish indicated.

1. Surface: Smooth, flat, mill finish.
2. High-Performance Organic Coating Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying and designating finishes. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's written instructions.
   a. Fluoropolymer 3-Coat Coating System: Manufacturer's standard 3-coat, thermocured system composed of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 1402.
      1) Color and Gloss: As selected from manufacturer's full range of choices for color and gloss.

C. Copper Sheet: ASTM B 370, cold-rolled copper sheet, H00 temper, unless otherwise indicated.

1. Weight (Thickness): 16 oz./sq. ft., unless otherwise indicated.

D. Stainless-Steel Sheet: ASTM A 666, Type 304, dead soft, fully annealed.

1. Finish: 2D (dull).

E. Terne-Coated Stainless-Steel Sheet: ASTM A 666, Type 304, dead-soft, fully annealed stainless-steel sheet, coated on both sides with terne alloy (80 percent lead, 20 percent tin) to produce a nominal total coating weight of 1.45 oz./sq. ft.

1. Thickness and Weight: 0.018 inch plus coating, weighing approximately 0.82 lb/sq. ft. including coating, unless otherwise indicated.
2. In lieu of spot tests to determine coating weight, manufacturer may submit nondestructive radiographic test results and certification showing that terne-coating weight of sheets furnished for Project complies with requirements.

2.02 UNDERLAYMENT MATERIALS:

A. Self-Adhering, Polymer-Modified, Bituminous Sheet Underlayment: ASTM D 1970, minimum 40 mils thick. Provide primer when recommended by underlayment manufacturer.

B. Building Paper: Minimum 5 lb/100 sq. ft., rosin sizing.

C. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felts.

2.03 MISCELLANEOUS MATERIALS:

A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and accessory items as required for a complete roofing system and as recommended by sheet metal manufacturer and fabricator for metal roofing work, unless otherwise indicated.

B. Expansion-Joint Sealant in accordance with Section 07900: For hooked-type expansion joints, which must be free to move, provide nonsetting, nonhardening, nonmigrating, heavy-bodied polyisobutylene sealant.

C. Terne Base Coating: Red iron-oxide/linseed oil paint, with iron oxide as 40 percent minimum of pigment and linseed oil as 50 percent minimum of vehicle.

D. Metal Accessories in accordance with Section 07600: Provide components matching sheet metal roofing in finish and material that are required for a complete roofing system, including the following:

1. Clips, flashings, and ridge closure strips.
2. Trim, copings, fascia.

E. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.

F. Elastomeric Joint Sealant: ASTM C 920, of base polymer, type, grade, class, and use classifications required to produce joints in roofing that will remain weathertight and as recommended by the roofing manufacturer for installation indicated and in accordance with Section 07900

G. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat, unless otherwise indicated. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.

H. Snow Guards: Section 07730.

2.04 FABRICATION:

A. General: Fabricate sheet metal roofing to comply with details shown, with metal roofing manufacturer's written instructions, and with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of installation indicated. For copper roofing, comply with details shown and with recommendations of CDA’s Copper Design Handbook.

B. Fabricate sheet metal to allow for expansion in running work sufficient to prevent leakage, damage, and deterioration of the Work. Form exposed sheet metal work to fit substrates without excessive oil canning, buckling, and tool marks, true to line and levels indicated, and with exposed edges folded back to form hems.

C. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used, or would not be sufficiently waterproof and weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant (concealed within joints).

D. Sealant Joints: Where movable, nonexpansion-type joints are indicated or required to produce weathertight seams, form metal to provide for proper installation of elastomeric sealant, in compliance with SMACNA standards.

E. Separations: Separate metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact with bituminous coating or other permanent separation as recommended by manufacturer or fabricator.

F. Lap-Seam Roof Panels: Manufacturer's standard factory-formed, lap-seam roof panel assembly designed for mechanical attachment of panels to roof purlins using exposed fasteners and sealants.

G. Standing-Seam Roof Panels: Manufacturer's standard factory-formed, standing-seam roof panel assembly designed for concealed mechanical attachment of panels to roof purlins or deck.
   1. Standing-seam roof assemblies vary among manufacturers. Revise paragraph below to reflect assembly desired.
   2. Clips: Provide minimum 0.0625-inch- thick, stainless-steel panel clips designed to meet negative-load requirements.
   3. Cleats: Mechanically seamed cleats formed from minimum 0.0250-inch- thick, stainless-steel or nylon-coated aluminum sheets.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions, with Installer present, for compliance with requirements indicated for conditions affecting performance of sheet metal roofing. Do not proceed with installation until unsatisfactory conditions have been corrected

3.02 PREPARATION:

A. Coordinate metal roofing with rain drainage work, flashing, trim, and construction of decking as specified in Section 05310, parapets, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

B. Promptly remove protective film, if any, from exposed surfaces of metal roofing. Strip with care to avoid damage to finish.

3.03 INSTALLATION, GENERAL:

A. Install roofing to comply with sheet metal roofing manufacturer's written instructions, unless otherwise indicated.

B. Separate dissimilar metals by painting each metal surface in area of contact with a bituminous coating, by applying rubberized-asphalt underlayment to each metal surface, or by other permanent separation as recommended by manufacturers of dissimilar metals.

C. Install felt underlayment and building paper slip sheet on substrate under metal roofing, unless otherwise recommended by sheet metal manufacturer. Use adhesive for temporary anchorage, where possible, to minimize use of mechanical fasteners under metal roofing. Apply from eave to ridge in shingle fashion and lap joints 2 inches minimum.

D. Underlayment is limited to placing building paper only directly under terne metal.

E. Coat back side of metal roofing with bituminous coating where it will contact wood, ferrous metal, or cementitious construction.

F. Paint back side of terne roofing with terne base coating, 1.0-mil dry film thickness, where slope of roofing is 3 inches per foot (1:4) or less.

G. Form and fabricate sheets, seams, strips, cleats, valleys, ridges, edge treatments, integral flashings, and other components of metal roofing to profiles, patterns, and drainage arrangements shown and as required for leakproof construction. Provide for thermal expansion and contraction of the Work. Seal joints as shown and as required for leakproof construction. Shop fabricate materials to greatest extent possible.

H. Sealant-Type Joints: Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature is moderate, between 40 and 70 deg F, at time of installation, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F. Comply with requirements of Section 07900: Joint Sealants for handling and installing sealants.

I. Fabricate and install work with lines and corners of exposed units true and accurate. Form exposed faces flat and free of buckles, excessive waves, and avoidable tool marks, considering temper and reflectivity of metal. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant. Fold back sheet metal to form a hem on concealed side of exposed edges, unless otherwise indicated.

J. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

K. Stainless-Steel Roofing: Tin edges of uncoated sheets to be soldered, for a width of 1-1/2 inches, using solder recommended for stainless steel and acid flux. Promptly remove every trace of acid flux residue from metal after tinning. Comply with manufacturer's recommended methods for cleaning and neutralization. Clean exposed surfaces of stainless steel of every substance that is visible or that might cause corrosion of metal.

L. Tin uncoated copper surfaces at edges of sheets to be soldered, for a width of 1-1/2 inches, using solder recommended for copper work. Where surfaces to be soldered are lead coated, do not tin edges, but wire brush lead coating before soldering.

M. Rivet joints in uncoated aluminum where necessary for strength. Clean exposed surfaces of every substance that is visible or that might cause corrosion of metal or deterioration of finish.

N. Install metal accessories in accordance with Section 07600.

O. Install snow guards in accordance with Section 07730.

3.04 CLEANING:

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

3.05 PROTECTION:

A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure metal roofing is without damage or deterioration at the time of Substantial Completion.

END OF SECTION

1. Comply with codes and regulations of the jurisdictional authorities.
2. ASTM: C516,C518, C549, C552, C665, C728, C1289, D41, D226, D312, D2626, D4586, E84.
3. FM: A/S4470, P7825.
4. FS: HH-I-1972/3.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to jobsite in their original unopened containers or wrappings clearly labeled with manufacturer's name and brand designation, referenced specification number, type, class and rating as applicable.

B. Store products in approved dry area and protect from contact with soil, exposure to the elements and temperatures lower than 40F or higher than 150F. Keep products dry; store rolled goods standing on end.

C. Handle products so as to prevent breakage of containers and damage to products.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
1. Application of roof insulation when ambient temperature is lower than 40F or when ice, frost or dampness are visible on the roof decks is prohibited.
2. Maintain temperature of 55F minimum in structure for 48 hours prior to, during and 48 hours after application of wall insulation.

B. Allowable Roof Loads:
1. During insulation application do not use equipment of weight which exceeds allowable roof load.

C. Coordinate insulation work with related roofing work.

PART 2 - PRODUCTS

2.01 ROOF INSULATION MATERIALS:

A. General: Use roof insulation materials acceptable to the roofing manufacturer. See related roofing specifications in other sections.

B. Insulation Board: One of the following materials for which installed thickness will produce overall average thermal resistance of R19.5, including decrease in thermal resistance value due to aging; and which is labeled and classified as a roof deck construction material by UL for use in Fire-Classified metal roof deck assemblies (TGKX), or by FM for use in Class-1 metal-roof-deck construction.
1. Composite polyisocyanurate (including polyurethane) board, ASTM C1289, Type III, factory faced with perlite insulation board on one side and asphalt-saturated felt on the other.
2. Perlite board, ASTM C728, Type 1; except with 35-psi compression resistance at five percent consolidation, and with integral factory-treatment designed to improve bond with built-up roofing membranes.

C. Tapered Insulation Board: Where roof slope through the use of tapered insulation is required, use approved insulation board as specified above, but factory fabricated so as to provide smooth drainage inclines (1/8-inch, 1/4-inch and 1/2-inch per 12 inches), as shown.

D. Asphalt Primer: ASTM D41.

E. Steep Asphalt: ASTM D312, Type III, or IV.

F. Asphalt-Saturated Felt: ASTM D226, Type I.

G. Asphalt Base Sheet: ASTM D2626.

H. Asphalt Cement (Asbestos-Free): ASTM D4586.

I. Asphalt for Glaze Coats: ASTM D312.

J. Adhesive: Manufacturer's standard.

K. Wood Nailers and Edges: Preservation treated per Section 06075.

L. Cant Strips and Tapered Edge Strips: Pre-fabricated from urethane or mineral aggregate board.

M. Nails and Tin Caps for Vapor Barriers: 11-gauge, annular-thread, 3/8-inch head, galvanized roofing nails and flat-disc galvanized-tin caps, 1-3/8 inch minimum diameter or galvanized combination nails and caps with one-inch heads.

N. Insulation Nails: Types standard with insulation manufacturer.

O. Clips and Fasteners: Types standard with metal-roof deck manufacturer; stainless steel or zinc coated, 18-gauge minimum.

2.02 WALL INSULATION MATERIALS:

A. Batt Insulation:
1. Fibrous flexible blankets faced with a reinforced foil-kraft facing vapro retarder.
2. Complies with ASTM C665, type III, Class B, Category 1.
3. Fire hazard classification rating of 25/50 or less, per ASTM E84.
4. Vapor Barrier Facing: Perms mazimum, 0.1 when tested in accordance with ASTM C518.
5. Thermal Resistance Minimum: R value of II except where indicated otherwise on the drawings. Thickness as indicated on drawings.

B. Loose-Fill Insulation:
1. Perlite: ASTM C549, Type IV (water-repellant and dust-control treated).
2. Vermiculite: ASTM C516, Type II (water-repellant treated), Premium Grade..

2.03 PERIMETER AND CAVITY WALL INSULATION:

A. Rigid Board types of cellular glass or polystyrene insulation with 15 psi compressive strength.
1. Cellar glass (Foamglass): ASTM C552. Minimum R value: 5.0 per inch of thickness
2. Polystyrene: ASTM C578, Minimum R value: 4.35 per inch of thickness with density of 1.0 lbs. Per cubic foot.

B. Adhesive and Fastenings: As recommended by the manufacturer.

C. Insulation inserts for concrete masonry units cores.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Prepare surfaces smooth, dry, clean, and free of projections, oil, grease, wax, rough mortar, debris and other substances that might prevent proper application of insulation.

B. Allow decks and wall surfaces to dry thoroughly before application of insulation. Test for dampness per manufacturer's recommendations.

C. Cut mortar joints flush with masonry walls. Remove fins and projections left after removal of concrete forms.

D. Back plaster walls with cement mortar, if necessary to obtain smooth surfaces.

3.02 APPLICATION OF ROOF INSULATION:

A. General Requirements for Application:
   1. Apply insulation in direct contact with roof deck or over vapor barrier, as shown. Keep roof-insulation materials dry before, during and after application. Place perlite side of composite insulation face up.
   2. Apply insulation to deck so that continuous longitudinal joints are parallel to short dimension of roof; stagger cross joints by starting alternate courses with half-size insulation boards. Keep insulation 1/2-inch clear of vertical surfaces.
   3. When using multiple layers of insulation, stagger the joints of each succeeding layer in both directions with respect to layer below. Embed succeeding layers firmly in solid mopping of steep asphalt.
   4. Mop sufficient area to provide complete embedment of one board at a time.
   5. Except for strip-mopping on metal decks, use 25 pounds minimum of asphalt per 100 square feet of roof deck for mopping each layer of insulation in place.
   6. Provide treated-wood nailers at edges of roofs and at intersections with vertical surfaces. Provide additional treated-wood nailers at necessary intervals for nailing insulation on non-nailable decks or for nailing roofing felt.
   7. Do not heat steep asphalt above 450F. Do not heat asphalt used for glaze coats above 400F. Apply steep asphalt at no less than 350F. Apply glaze coat at no less than 325F.

B. Application on Concrete Decks:
   1. Completely cover concrete decks with asphalt primer at minimum rate of one gallon per 100 square feet of roof surface.
   2. Vapor barrier:
      a. Provide vapor barrier consisting of two plies of asphalt-saturated felt with each ply lapped not less than 19 inches and mopped-in with steep asphalt. Vapor barrier, consisting of one layer of asphalt base sheets and weighing not less than 35 pounds minimum per 100 square feet, may be provided in lieu of two felt plies. Lap base sheets not less than four inches at sides and ends; solidly mop-in with steep asphalt.
      b. Mop-in vapor barriers at rate of 25 pounds minimum of steep asphalt per 100 square feet. Ensure that vapor barriers are free of wrinkles and buckles. Press air bubbles out to obtain proper adhesion between surfaces.
      c. At walls, edges and vertical projections, extend vapor barrier six inches to form lap to be wrapped around edge of insulation.
   3. Apply insulation as specified under general requirements for application.
   4. If roof slope exceeds one inch per foot, provide wood nailers for nailing insulation to roof deck. Use six nails minimum per eight square feet of insulation.

C. Application on Steel Decks:

1. Apply insulation so that joints occur on solid bearing surfaces only rather than over open ribs. Apply insulation of the indicated thickness and as required to achieve the roof slopes indicated.
2. Before insulation is installed, uniformly strip-coat high sections of steel deck with asphalt primer using 1/2-gallon minimum per 100 square feet of roof surface. Allow primer to dry.
3. Strip-mop high sections of deck using not less than 12 pounds of steep asphalt per 100 square feet of roof surface. Do not permit asphalt to flow into ribs or flutes of decking.
4. Place insulation while asphalt is still hot and fluid. When multiple layers of insulation are used, mop-in second layer and succeeding layers as specified under general requirements for application.
5. Fastening of insulation on steel decks:
    a. If roof slope exceeds one inch per foot, supplement asphalt moppings with mechanical fasteners. Where mechanical fastening is required, provide approved steel-deck, manufacturer's standard, nonpiercing, double-prong steel clips designed to fit into ribs of decking.
    b. Provide fastener of length necessary to accommodate thickness of insulation and with holding power 120 pounds minimum per fastener.
    c. Provide clips at the rate of 25 clips minimum per 100 square feet.

D. Cant Strips and Tapered Edge Strips:
1. Cant strips:
    a. Where shown or specified, provide 45-degree cant strips at intersections of roof with vertical surfaces extending above roof. Place cant strips on insulation and fit flush against vertical surfaces.
    b. Where possible, nail cant strips to adjoining surfaces. For installation against non-nailable materials, place cant strips in heavy mopping of steep asphalt or set in asphalt cement.
    c. Do not install projections, such as vent pipes and braces, through cant strips or within 10 inches from cant strips.
2. Tapered edge strips:
    a. Where shown or specified, provide tapered edge strips in right angle formed by junction of roof and wood nailing strips that extend above roof level. Fit strips flush against vertical surfaces of wood nailing strips.
    b. Where possible, nail edge strips to adjoining surfaces. Where installed against non-nailable materials, apply strips in heavy mopping of steep asphalt or set in asphalt cement.

E. Protection:
1. Cover each day's application of insulation, which cannot be roofed over, with at least one glaze coat of hot bitumen.
2. Protect open ends of each day's work with temporary water cut-offs; remove cut-offs when work is resumed.
3. Protect open spaces between insulation and parapets or other walls and spaces at curbs, scuttles, expansion joints and similar locations until permanent roofing and flashing is applied. Storing, walking, wheeling or trucking directly on insulation or on roofed surfaces is prohibited; provide smooth, clean board or plank walkways, runways and platforms as necessary.
4. Limit storage loads on platforms and wheeling loads to 40 psf uniformly distributed. Limit size and weight of mechanical equipment used for insulation work so that deflection of roof deck under its use does not exceed 1/240 of deck span.

3.03 APPLICATION OF MASONRY-CELL WALL INSULATION:

A. Follow manufacturer's recommended installation practices.

B. Pour loose-fill insulation into cells of concrete masonry units as masonry work progresses. Use approved procedures to ensure complete filling of cells.

C. Minimize free fall impact and dust formation.

3.04 APPLICATION OF BATT INSULATION:

A. The vapor barrier facing shall face toward the warm-in-winter side of the space.

B. Lay batts on top of soffit tightly butted together.

C. Attach wall mounted batts with, mechanical fasteners as required for permanent installation.

3.05 APPLICATION OF PERIMETER CAVITY WALL INSULATION:

A. Secure vertical insulation with mechanical fasteners sufficient to permanently retain all insulation in place during subsequent construction operations.

B. Fitted with tight butt joints with openings for penetrations nearly cut for tight fit.

C. Placed just prior to subsequent construction operations to prevent damage of insulation left exposed. Coordinate with masonry work. Prevent damage during placement of fill and compaction or concrete against insulation.

D. Place insulation in concrete masonry unit cores at plant prior to job site delivery.

3.06 CLEAN-UP:

A. Clean up rubbish and debris caused by this work and remove from site.

B. Remove drippings of asphalt and adhesives in exposed places on brick, concrete, steel, metal or other surfaces.

END OF SECTION

SECTION 07515

BUILT-UP ROOFING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing built-up roofing.

B. Related Work Specified Elsewhere:
   1. Thermal insulation, nailers and cants: Section 07210.
   2. Metal counter flashing and other sheet metal: Section 07600.
   3. Roof accessories: Section 07730.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. ASTM: D41, D312, D1668, D1863, D2178, , D4586.
   3. National Roofing Contractor's Association (NRCA):The NCRA Roofing and Waterproofing Manual.

B. Single Source: Provide products as produced or recommended by the roofing system manufacturer.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Shop Drawings:
      a. Include the following:
         1) Manufacturer's material, handling, and application instructions.
         2) Step-by-step application procedure proposed.
         3) Show perimeter details, tapered insulation layout (as applicable), penetration details, drainage details and other typical and special conditions.
         4) Staging plan showing access points, waste disposal, storage areas, etc.
   2. Certification:
      a. Submit certification from manufacturer of roofing, that roofing applicator is approved by manufacturer and has successfully performed at least three satisfactory roofing installations using materials and methods similar to those specified.
      b. Certification that materials furnished meet specified requirements and are compatible with each other and with adjacent materials under Related Work Specified Elsewhere.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to jobsite in their original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type, class and rating as applicable.

B. Store products in approved dry area with roll goods standing on ends and protect from contact with soil and from exposure to the elements. Keep products dry.

C. Handle products so as to prevent breakage of containers and damage to products.

D. Do not exceed designed live load of roof deck when stockpiling materials in areas of work.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
1. Application of roofing when precipitation is occurring or when ice, frost or dampness is visible on roof decks is prohibited.
2. Application of roofing when ambient temperature is lower than 40F is prohibited, unless otherwise approved.
3. Maintain rolls of felt at 60F minimum 24 hours minimum prior to installation.

1.06 WARRANTY:

A. One year in addition to the requirements of the General Provisions for a total of two years.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General:
1. Insofar as practicable, furnish products produced or recommended by a single roofing system manufacturer, including roofing system products specified in other sections.

B. Thermal Insulation, Nailers and Cants: Section 07210.

C. Asphalt Primer: ASTM D41.

D. Asphalt: ASTM D312.
1. Type I, 135F-151F softening point for level to 1/4-inch slope *(use not permitted)*
2. Type II, 158F-176F softening point for 1/4-inch to one-inch slope.
3. Type III, 185F-205F softening point for one-inch to three-inch slope.
4. Type IV, 210F-225F softening point for three-inch to six-inch slope.

E. Asphalt Cement(Asbestos-Free): ASTM D4586.

F. Asphalt-Saturated and Coated Organic Felt Base Sheet: ASTM D2626 (use not permitted).

G. Asphalt-Saturated Organic Roofing Felt: ASTM D226, Type I, perforated *(use not permitted)*.

H. Asphalt Glass Felt: ASTM D2178, Type IV or Type VI.

I. Base Flashing Cap Sheet: Roofing system manufacturer's standard asphalt impregnated and coated composite sheet, glass fiber or polyester reinforced, with or without surface granules.

J. Aggregate for Surfacing: ASTM D1863, light-colored crushed stone, slag or gravel, opaque to ultraviolet radiation.

K. Walkway Surface: Homogenous core of asphalt, plasticizers and inert fillers bonded by heat and pressure between two saturated and coated inorganic sheets, with the walking surface

finished with gray ceramic granules. Supply in 36-inch wide by 72-inch long sheets, 1/2-inch thick minimum.

L. Nails: 11-gauge, annular-thread, galvanized roofing nails with 3/8-inch diameter head or combination nail with head one-inch square minimum.

M. Tin Caps: Flat discs of galvanized sheet steel 28-gauge minimum and 1-3/8 inches minimum diameter.

N. Combination Nails: Square-head cap 11-gauge, hot-dip galvanized, annular thread with one-inch diameter cap.

O. Glass-Fiber Fabric: Woven glass cloth, treated with asphalt, ASTM D1668, Type I.

P. Metal Counter Flashing and Other Sheet Metal: Section 07600.

Q. Roof Accessories: Section 07730.

PART 3 - EXECUTION

3.01 EXAMINATION AND PREPARATION OF SURFACES:

A. Clean substrates of dust, debris and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.

B. Examine substrates, areas, and conditions under which roofing will be applied, with installer present, for compliance with requirements.

C. Verify proper secure placement of roof openings, penetrations, insulation, roof accessories and roof drains.

D. Verify that substrates are smooth, dry, clean and free of projections or debris that might damage roofing materials.

E. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.02 INSTALLATION:

A. General: Perform installation in accordance with the NCRA Roofing and Waterproofing Manual unless specified or shown differently.
   1. Apply roofing perpendicular to roof slope progressively and continuously. Provide starter sheets to maintain specified number of felt plies throughout roof. Extend roofing plies to tops of cant strips.
   2. Protect edges of each day's application of felt, except for coated base sheet, with glaze coat of hot Type-III asphalt. Apply glaze coat at minimum rate of 15 pounds of asphalt per 100 square feet of roof surface.
   3. Do not store materials on applied roofing. Provide sufficient crew to complete roofing work on area begun before end of each day's work.
   4. Roll felt into bitumen not more than three feet behind mop; broom thoroughly with roofer's smoothing brushes to ensure thorough bonding of sheets to eliminate air pockets, wrinkling and buckling. Felt may be machine applied if approved. Do not lay plies dry and turn back laps for mopping between plies.
   5. Heat Types-II, III and IV asphalts 450F maximum; do not keep heated overnight.

6. Apply asphalt at no less than 350F. Use thermometers to check temperature of asphalt during heating and application. Keep kettle operator in attendance during entire operation to ensure that maximum specified temperatures are not exceeded.
7. Provide smooth, clear, board or plank runways and platforms near supports for traffic over partially or completely finished roofing.
8. Follow commercial practice and recommendations of manufacturer and supplier for handling and use of materials, except as otherwise specified.

B. Materials Schedule:
1. Each of the following for each 100 square feet of roof area:

Materials	Specification Amount
Base sheet	1 ply
Felt	3 plies
Asphalt - on deck	25 pounds
Asphalt - between plies	60 pounds
Asphalt - top pouring	60 pounds
Aggregate: One of the following: Slag Gravel or crushed stone	 300 pounds 400 pounds

2. Base flashing is additional to the quantities above.

C. Application:
1. For direct application to concrete decks, coat decks uniformly with asphalt primer using not less than one gallon per square of roof area and allow to dry thoroughly.
2. Apply hot Type-III or Type IV asphalt uniformly in a solid mopping over primer or insulation at minimum rate of 25 pounds of asphalt per 100 square feet. On roofs of precast units, apply felt strips four inches or more in width centered over joints of precast units in cold-applied asphalt cement before solid mopping. Apply base sheet in hot asphalt with ends and edges lapped four inches over preceding sheet and sealed with hot asphalt.
3. Apply hot asphalt uniformly to base sheet at minimum rate of 20 pounds per 100 square feet. Apply three felt plies in hot asphalt, shingle fashion, each sheet in each ply lapping 24-3/4 inches over preceding ply. Lap ends of sheets six inches minimum and stagger laps in adjacent courses 12 inches minimum. Mop hot asphalt full lap-width of each ply so that felt never touches felt. Apply not less than 20 pounds of asphalt per 100 square feet between successive plies.
4. On roof slopes greater than one inch per foot, nail each ply of felt on slopes as specified. Correct fishmouths, breaks, blisters and other defects before flood-coating roofing.
5. Flood coat: After felt flashing applications, repairs and corrective actions have been completed and approved, coat entire surface uniformly with hot asphalt, poured from dipper, at minimum rate of 60 pounds per 100 square feet.
6. Aggregate surfacing: Immediately embed gravel, crushed stone or slag into hot asphalt.
7. Double surfacing: Provide double surfacing of aggregate in addition to normal requirement under each board of walkway-surface material as follows:
   a. Apply not less than 80 pounds of hot asphalt poured from dipper per 100 square feet of roof area.

b. Embed immediately into hot asphalt 200 pounds minimum of slag or 300 pounds minimum of gravel or crushed stone.

D. Nailing On Roof Slopes Greater Than One Inch Per Foot:
1. Nail each ply of felt. Run felt perpendicular to roof slope and nail to embedded nailers parallel to slope.
2. Nail felt to each nailer with two nails spaced approximately two and eight inches from upper edge of felt.

E. Base Flashing: Follow NRCA Roofing and Waterproofing Manual details and roofing system manufacturer's details.
1. Provide flashing in angles formed where roof decks abut walls, curbs, ventilators, pipes and other vertical surfaces and wherever necessary to make work watertight.
2. Prime walls and curbs; allow to dry before flashing is applied.
3. Apply base flashing in two layers: first of asphalt glass felt and topped with base flashing cap sheet cut in strips 12 feet long maximum with reinforced fabric side toward wall.
4. Extend flashing felt onto roof over membrane six to eight inches from toe of cant. Nail felt 1-1/2 inches from top edge of felt with roofing nails and tin caps at 10-inch maximum spacing.
5. Seal top of flashing with strip of glass fiber fabric embedded in 1/8-inch thick asphalt cement, extending from one-inch above top of felt to one-inch below nail heads.
6. Lap ends of felt three inches minimum, staggered in each ply, and seal watertight with asphalt cement. Apply six-inch wide strip of asphalt-saturated felt with asphalt cement to seal lower edge of flashing installation.
7. Cement felt to underlying surfaces and to each other with asphalt cement applied not less than 1/16-inch thick or 35 pounds per 100 square feet for each coating.

F. Stripping-In:
1. Strip-in roof-accessory aprons, pipe sleeves and metal flashings as follows:
   a. Prime surfaces and allow to dry. Strip-in with two layers of asphalt-saturated felt cemented with asphalt cement.
   b. Extend felt three and six inches, respectively, beyond edge of apron, flange or flashing.
2. Gravel stops, fascias and scuppers:
   a. Strip-in with two layers of asphalt-saturated felt, one 10-inch strip and one 12-inch strip.
   b. Solidly mop strips with hot bitumen.

G. Roof-Drain Flashing Application:
1. Strip-in roof drain with two layers of asphalt-saturated felt, one 10 inches wide and one 12 inches wide, set in asphalt cement or hot bitumen.
2. Heavily coat flashing ring of drain with asphalt cement before installing felt flashing. Clamp roofing felt and felt flashing securely in drain clamping ring.
3. Apply trowel coat of asphalt cement width of trowel on top of felt around clamping ring before flood coat and application of aggregate. Embed aggregate into asphalt cement.

H. Metal Fascias and Flashings:
1. Where metal fascias or other metal flashing extend into built-up roofing, extend felt plies under metal with first two plies turned over succeeding plies and back 12 inches.
2. After metal flashing is placed, apply two plies of asphalt-saturated felt flashing, set in pitch-base asphalt cement, over that part of metal extending onto roof.

I. Approval of Flashing: Obtain approval of complete flashing and connections of roofing with other work before applying final coating and surfacing materials.

J. Traffic Surfaces: Apply walkway-surface material in hot asphalt over double-aggregate surfacing in individual boards with 10-inch separation between each board. Extend separation through top surfacing to provide drain through walkways at level of original surfacing.

3.03 FIELD QUALITY CONTROL:

A. Tests:
1. The Engineer may cut six-inch by 24-inch test specimens from roof; one specimen for each 5,000 square feet, but not less than one specimen for each roof level or area. In the event of test cuts, immediately restore roof to its original state, using same number of plies and moppings, shingled-out not less than 26 inches on sides of cut.
2. Should examination and test of specimens disclose lack of specified material or nonconformity to specified requirements, the Engineer may order removal of roofing and replacement as specified, order that additional materials be applied uniformly over entire surface at least to the amount of deficiency disclosed in test specimens or order other corrections to be made.

B. Prevention of Roof-Drain System Clogging:
1. Prevent asphalt and other roofing materials from entering and clogging roof drains and conductors.
2. Repair or replace clogged or damaged components as directed.
3. Remove roof-drain plugs when no work is taking place or during precipitation.

C. Correct deficiencies in or remove built-up roofing that does not comply with requirements Repair substrates, reinstall roofing and repair flashings to a condition free of damage and deterioration.

D. Prevent asphalt and other roofing materials from spilling or migrating onto surfaces of other construction. Clean spillage using cleaning agents and procedures recommended by manufacturer of affected construction.

3.04 CLEAN-UP:

A. Clean up rubbish and debris caused by this work and remove from the site.

B. Promptly remove drippings of pitch and asphalt in exposed places on brick, concrete, steel, copper and other surfaces to prevent irreparable damage to exposed finish surfaces.

END OF SECTION

SECTION 07600

FLASHING AND SHEET METAL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing miscellaneous-waterproofing sheet metal including metal flashings, copings, exposed trim, fasciae, gravel stops, reglets, scuppers, gutters and downspouts, conductor heads, splash pans, drip edges, roof and roof-to-wall expansion joint covers, shower pans, overhead piping safety pans, metal accessories, gutter screens, strainers, red-rosin paper, solder, and related nailing strips and miscellaneous wood supports.

B. Related Work Specified Elsewhere:
   1. Brick Masonry: Section 04215.
   2. Concrete Unit Masonry: Section 04220
   3. Rough Carpentry: Section 06100.
   4. Seals and Sealants: Section 07900.
   5. Roof Accessories: Section 07730.
   6. Sheetmetal Roofing Systems: Section 07411.
   7. Built-up Roofing: Section 07515.

1.02 PERFORMANCE REQUIREMENTS:

A. General: Install sheet metal flashing and trim to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.

B. Fabricate and install flashings at roof edges to comply with recommendations of FM Loss Prevention Data Sheet 1-49 for the following wind zone:
   1. Wind Zone 3: Wind pressures of 46 to 104 psf.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Product Data including manufacturer's material and finish data, installation instructions, and general recommendations for each specified flashing material and fabricated product.
   2. Shop Drawings:
      a. Show both shop-fabricated and site-fabricated work, indicating where each item is fabricated. Include complete details of joints, supports and fasteners, in accordance with SMACNA Architectural Sheet Metal Manual standard details where applicable.
      b. Show dimensions and locations of wood nailing strips, miscellaneous wood supports and details of installation.
      c. Fabricated Masonry Flashing: Detail corner units, end-dam units, and other special applications.
   3. Samples: Three of each type of the following materials used in the work:
      a. Stainless steel: 12 inches square.
      b. Lead-coated copper: 12 inches square.
      c. Bituminous paint: Pint containers.
      d. Aluminum coping: 12-inch by 12-inch corner section.
      e. Stainless steel coping: 12-inch by 12-inch corner section.

f. Reglets: 12-inch strips.
g. Expansion-joint cover: 12-inch strips.
h. Downspout and gutter: 12-inch length with anchor strap.
i. Copper-Laminated Flashing: 12 inches square.
j. Coil-coated galvanized steel: 12 inches square.
k. Copper: 12 inches square.
l. Metal accessories.

B. Certification.

1.04 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. SMACNA: Architectural Sheet Metal Manual.
3. FS: QQ-L-201, UU-B-790.
4. AAMA: 606.1.
5. NRCA: Roofing and Waterproofing Manual.
6. ASTM: A167, A755, B32, B101, B209, B221, B370.
7. UL: 580 for Class 90 wind-uplift resistance.
8. FM: Loss Prevention Data Sheet 1-49.
9. Copper Development Association: Copper in Architecture Handbook.

B. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.

C. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation. Ensure best possible weather resistance, durability of Work, and protection of materials and finishes.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to jobsite in original unopened containers clearly marked with manufacturer's name and brand designation, reference specification number, type and class as applicable.

B. Store products in approved dry area and protect from contact with soil and exposure to the elements. Keep products dry.

C. Handle products so as to prevent breakage of containers and damage to products.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Stainless Steel:
1. Through-wall flashing (mechanically keyed) sheets: ASTM A167, Type 304, soft annealed, minimum thickness 0.012 inch.
2. Fascia, exposed trims, reglets, roof drain flashings, base flashings, counterflashings, flashing receivers, valley flashings, drip edges, eave flashings, equipment support flashings, roof penetration flashings, roof expansion joint covers, scuppers: ASTM A167, Type 304, hard tempered, minimum thickness 0.0187 inch, unless otherwise shown or indicated.

3. Copings, gravel stops, and roof-to-wall expansion joint covers: ASTM A167, Type 304, hard tempered, minimum thickness 0.025 inch, unless otherwise shown or indicated.
    a. Backing or stiffeners required to prevent oil-canning and waviness.
    b. Finish: No. 2D.

B. Copper Sheet and Strips: ASTM B370; temper H00, cold-rolled except where temper 060 is required for forming:
1. Shower pans: Not less than 16-ounces/square foot, unless otherwise shown.
2. Concealed copper-laminated flashing:
    a. Manufacturer's standard laminated flashing consisting of 7-oz./sq. ft.sheet copper bonded with asphalt between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.

C. Lead-Coated Copper:
1. ASTM B101, cold-rolled copper sheet with temper O60 (soft) for flashing, temper H00 or H01 for other uses as appropriate, sheet weight and lead coating weight as specified below:
    a. Gutters with girth up to 20 inches, downspouts, conductor heads, reglets, base flashings, counterflashings, flashing receivers, valley flashings, drip edges, eave flashings, equipment support flashings, roof drain flashings, roof penetration flashings, roof expansion joint covers, roof-to-wall expansion joint covers, and splash pans: Copper sheet weighing not less than 16 ounces/square foot.
    b. Scuppers: Copper sheet weighing not less than 20 ounces/square foot.
    c. Gutters with girth larger than 20 inches and overhead piping safety pans: Copper sheet weighing not less than 24 ounces/square foot.
    d. Both sides of copper sheet coated with lead weighing not less than 12 nor more than 15 pounds/100 square feet, unless otherwise indicated.

D. Coil-Coated Galvanized Steel Sheet:
1. Zinc-coated, commercial quality steel sheet with thickness as specified below conforming to ASTM A755, G90 coating designation, coil coated with high-performance fluoropolymer coating of not less than 1 mil thick (0.2 mil primer and 0.8 mil fluoropolymer) each side, unless otherwise specified.
2. Counter flashings and flashings receivers: Minimum thickness of steel sheet 0.0217 inch, unless otherwise shown or indicated.
3. Fasciae, trims, drip edges, eave flashings, base flashings, valley flashings, and equipment support flashings: Minimum thickness of steel sheet 0.0276 inch, unless otherwise shown or indicated.
    a. Backing or stiffeners for fasciae and trims required to prevent oil-canning and waviness.

E. Aluminum:
1. Extruded anodized fasciae, exposed trims, copings and gravel stops: ASTM B221, Alloy 6063-T52, minimum thickness 0.125 inch.
2. Alloy sheet anodized scuppers, roof expansion joint covers, and roof-to-wall expansion joint covers: ASTM B209, Alloy 5005-H14, minimum thickness 0.050 inch.
3. Alloy sheet anodized drip edges, eave flashings, base flashings, counterflashings, and flashing receivers: ASTM B209, Alloy 5005-H14, minimum thickness 0.040 inch.
4. Finish: Class I color anodized finish with anodic layer thicker than 0.7 mil, dark bronze color, per AAMA 606.1, Guide Specifications and Inspection Methods for Integral Color Anodic Finishes for Architectural Aluminum.

F. Lead:
   1. Flashing for plumbing vents:
      a. Sheet lead, FS QQ-L-201, minimum 2-1/2 pounds per square foot.

G. Miscellaneous Items:
   1. Red-rosin paper:
      a. FS UU-B-790, Type I, Style 1b, 5 lb/sq., sized building paper.
   2. Vinyl tape: As recommended by the metal product manufacturer as a dissimilar metal separator.
   3. Wood blocking: Section 06100.
   4. Bituminous Paint: As recommended by the manufacturer as a dissimilar metal separator.
   5. Solder: ASTM B32, with flux-core; of the following solder alloys. Use another alloy if it is demonstrated to the Engineer that better results, including visual as applicable, can be achieved on the particular metals being joined.
      a. For stainless steel: Tin/silver solder, Alloy Grade Sn96, with acid flux of type recommended by stainless steel manufacturer.
      b. For copper: 50-50 tin/lead solder, Alloy Grade Sn50, with rosin flux.For lead-coated copper: 60-40 tin/lead solder, Alloy Grade Sn60, with rosin flux.
   6. Sealant:
      a. Elastomeric: Section 07900.
      b. Epoxy Seam Sealer: Two-part, non-corrosive, aluminum seam-cementing compound as recommended by aluminum manufacturer for exterior and interior non-moving joints including riveted joints.
      c. Mastic Sealant: Polyisobutylene, nonhardening, nonskinning, nondrying, nonmigrating sealant.
   7. Metal Accessories and Fasteners: Provide sheet metal clips, straps, anchoring devices, and similar accessory units as required for installation of Work, matching, matching finish of exposed heads, or compatible with material being installed as approved; noncorrosive; size and thickness required for performance per approved samples.
   8. Gutter Screen: 1/4-inch non-corrosive hardware cloth installed in sheet metal frames.
   9. Adhesives: Type recommended by flashing sheetmetal manufacturer for waterproof and weather-resistant seaming and adhesive application of flashing sheetmetal.
   10. Roofing Cement: ASTM D4586, Type I, asbestos free, asphalt based.
   11. Asphalt Mastic for under flashing receivers and counterflashing and paint on lap seams and base flashing: SSPC-Paint 12, solvent-type mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry-film thickness per coat.

2.02 FABRICATION, GENERAL:

A. Sheet Metal Fabrication Standard: Fabricate sheet metal flashing and trim to comply with recommendations of SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of the item indicated.

B. Comply with details shown to fabricate sheet metal flashing and trim that fit substrates and result in waterproof and weather-resistant performance once installed. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

C. Form exposed sheet metal Work that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems.

D. Expansion Provisions: Space movement joints at maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions in the Work cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints or intermeshing hooked flanges, not less than one-inch deep, filled with mastic sealant (concealed within the joints).

E. Fabricate nonmoving joints with flat-lock seams. For tin edges to be seamed, form seams and solder. For aluminum to be seamed, form seams and seal with epoxy seam sealer and rivet joints for additional strength as approved.

F. Sealed joints: Form movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.

G. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of sheet metal exposed to public view.

H. Fabricate cleats and attachment devices from same material as sheet metal component being anchored or from compatible, noncorrosive metal recommended by sheet metal manufacturer.
   1. Size: As recommended by SMACNA manual or sheet metal manufacturer for application but never less than thickness of metal being secured.

2.03 SHEETMETAL FABRICATIONS:

A. Downspout: Plain, rectangular, lead-coated copper in accordance with SMACNA Architectural Sheet Metal Manual standards, unless otherwise shown.

B. Gutters: Lead-coated copper in accordance with SMACNA standards.

C. Gutter Screen: Fabricate screen and frame of approved material

D. Reglets:
   1. Stainless steel or lead-coated copper, matching flashing material, closed-slot, friction-type.

E. Roof and Wall-to-Roof Expansion Joint Covers:
   1. Combination of neoprene and lead-coated copper or stainless steel, with the following additional requirements:
      a. Cover with neoprene bonded to metal edgings by means of neoprene-based adhesive comprising primer and vulcanizing cement to produce high-strength bond.
      b. For neoprene part of cover, cured neoprene sheet, tensile strength 1,500-psi minimum, elongation 250-percent minimum, bonded to metal with peel-pull value of 25 pounds per inch minimum at right angles; thickness and width as shown.
      c. Edgings of metal cover, four inches wide, perforated with holes four inches on centers minimum.

F. Coping and Gravel Stops:
   1. Extruded aluminum or stainless steel, assemblies tested for wind-uplift resistance in accordance with UL 580 for Class 90-uplift resistance, or greater as required by jurisdictional authority, with testing performed by testing agency acceptable to the Engineer.

a. Size: 10-foot long sections, with factory-fabricated corners and intersections, formed with no visible fasteners.
b. Movement joint design: Incorporate a waterproof seal using an internal weep system and rubber or vinyl seals into the non-welded joints.
c. Fasteners and clips: As standard with the manufacturer for required wind-uplift resistance. Where exposed, finish to match the metal finish.

G. Flashing for Plumbing Vents:
1. Lead, sized to extend at least four inches horizontally on roof around pipe, over pipe, and one-inch inside pipe.

H. Strainer:
1. Stainless-steel ,12-gauge wires spaced not greater than 1/2-inch apart, as shown and as approved.

I. Miscellaneous-waterproofing sheetmetal flashings, fasciae, trims, drip edges, scuppers, conductor heads, shower pans, splash pans, and overhead piping safety pans:
1. Fabricated from material as previously specified, sized as shown and as approved.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Clean dirt, debris, grease, oil and other foreign substances from surfaces that are to receive metalwork. Coordinate with work of other Sections: 04215, 04220, 07411, and 07730.

3.02 INSTALLATION:

A. Coordinate flashing and sheet metal with the work of other trades. Shop-fabricate the work whenever possible. Provide for expansion and contraction of sheet metal.

B. Install the work of this Section in accordance with the NRCA Roofing and Waterproofing Manual, performance requirements, manufacturers' instructions and SMACNA's Architectural Sheet Metal Manual. Anchor units securely in place by methods indicated and conceal fasteners where possible. Set units true to line and level with exposed edges folded back to form hems. Install exposed sheetmetal without excessive oil canning, buckling and tool marks. Verify shapes and dimensions of surfaces to be covered prior to fabrication and trim to fit substrates. Install work with laps, joints and seams that will be permanently watertight and weatherproof. Provide for thermal expansion of metal units. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently weatherproof and waterproof, form expansion joints of intermeshing hooked flanges not less than one-inch deep and fill with mastic sealant concealed within joints. Form nonexpansion joints in metal to accommodate elastomeric sealant to comply with SMACNA standards. Fill joint with sealant and form metal to completely conceal sealant. Use joint adhesive for non-moving joints specified not to be soldered. Fabricate non-moving seams in sheetmetal with flat-lock seams, except fabricate non-moving seams in aluminum with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints as approved for additional strength.. Tin edges to be seamed, form seams and solder.

C. Perform cutting, drilling and other operations in connection with sheet metal work to accommodate work of other trades. Provide accessories as recommended by SMACNA Architectural Sheet Metal Manual.

D. Where sheet metal abuts or interfaces with adjacent materials, join as shown on approved shop drawings. Isolate dissimilar metals by use of compatible coatings or other approved methods. Apply red-rosin paper backing for sheet metal applied to any surface to permit movement caused by expansion or to prevent galvanic action.

E. Soldering:
1. Clean surfaces to be soldered to remove oils and foreign matter. Brush liberal amount of flux on seams, solder immediately, neutralize acid and clean.
2. Solder slowly, thoroughly heating seam and completely sweating solder through full width of seam. Use ample solder for full width along seams.
3. Do not solder aluminum and coil-coated galvanized steel sheet. Pre-tinning is not required for lead and lead-coated copper. Do not use torches for soldering, heat surfaces to receive solder and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

F. Seams:
1. Flat lock: 3/4-inch wide, minimum.
2. Solder lap: One-inch wide, minimum
3. Unsoldered plain lap: Three-inches wide, minimum.
4. Seams: Corresponding to direction of flow.

G. Form flashings from material shown or specified made up from sheets eight to 10 feet long with locked and soldered seams into units of not more than 16 feet. Join units together with three-inch wide loose-locked seams filled with sealant before units are joined. Runs of flashing shorter than 16 feet will not require loose-seam joints. Miter corners and join by locked and soldered joints.

H. Install expansion-joint covers as indicated and in accordance with manufacturer's recommendations. Splice ends of adjoining lengths of covers with neoprene tabs applied to both faces with approved adhesive. Provide prefabricated corners, intersections and crossovers.

I. Form cap flashing at parapet walls and other vertical surfaces to extend into metal reglets built into structure and prefilled with sealant. Lap built-up roof flashings and form metal to provide spring action against roof flashings. Prior to installation, coat flashing portions to be concealed with bituminous paint.

J. Where cants do not occur at intersections of roof decks and vertical surfaces of walls and other construction, provide flashings. Extend base flashings up vertical surfaces eight inches unless otherwise shown, behind metal cap flashing and out onto roof or horizontal surface not less than eight inches. Coat back sides of base flashing with bituminous paint and set into angle formed by roof and vertical surfaces after three plies of roofing-felt reinforcement have been laid. Nail flange with nails spaced three inches on centers and 3/4-inch from edge into wooden nailer provided in roof slab. Secure metal flashing at roof edges according to FM Loss Prevention Data Sheet 1-49 for specified wind zone.

K. Reglets: Form reglets to reproduce detail and design shown. Form sharp, even and true profiles, bends and intersections. Lock or lap joints and solder or reinforce joints as shown on approved shop drawings or specified. Install reglets to receive counterflashings: Furnish reglets for installation under Division 3 concrete and under Division 4 masonry.

L. Coping: Install coping in accordance with manufacturer's recommendations. Locate fasteners and clips as follows:
1. At joints and at five-foot maximum intervals.
2. Center butt joints over anchor clips.
3. Secure in place allowing for thermal expansion and establishing watertight joint.

M. Counterflashings: Coordinate installation of counterflashings with installation of assemblies to be protected by counterflashing. Install counterflashings in reglets or receivers. Secure in a waterproof manner by means of snap-in installation and sealant, lead wedges and sealant, interlocking folded seam, or blind rivets and sealant. Lap counterflashing joints a minimum of 2 inches and bed with sealant.

N. Roof-Drainage System: Install drainage items fabricated from sheet metal, with straps, adhesives, and anchors recommended by SMACNA's Manual or the item manufacturer, to drain roof in the most efficient manner. Coordinate roof-drain flashing installation with roof-drainage system installation. Coordinate flashing and sheet metal items for steep-sloped roofs with roofing installation. Install strainer at top of downspout.

O. Equipment Support Flashing: Coordinate equipment support flashing installation with roofing and equipment installation. Weld or seal flashing to equipment support member.

P. Roof-Penetration Flashing: Coordinate roof-penetration flashing installation with roofing and installation of items penetrating roof. Install flashing as follows:
1. Turn flashing down inside vent piping, being careful not to block vent piping with flashing.
2. Seal and clamp flashing to pipes penetrating roof, other than lead flashing on vent piping.

Q. Install continuous gutter screens on gutters with noncorrosive fasteners, arranged as hinged units to swing open for cleaning gutters.

R. Overhead-Piping Safety Pan: Suspend pans from pipe and install drain line to plumbing waste or drain line.

S. Splash Pans: Install where downspouts discharge on low-sloped roofs, unless otherwise shown. Set in roof cement or sealant compatible with roofing material.

T. Install sealant in accordance with Section 07900.

U. Install wood blocking in accordance with Section 06100.

3.03 CLEAN-UP:

A. Clean up rubbish and debris caused by this work and remove from site.

B. Promptly remove drippings and stains of materials from exposed surfaces.

C. Provide final protection and maintain conditions that ensure sheet metal flashing and trim Work during construction is without damage or deterioration other than natural weathering at the time of Substantial Completion.

END OF SECTION

SECTION 07730

ROOF ACCESSORIES

PART1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing roof hatches, equipment supports, roof vents, snow guards and miscellaneous roof accessories.

B. Related Work Specified Elsewhere:
1. Rough Carpentry: Section 06100.
2. Seals and Sealants: Section 07900.
3. Roof Anchors: Section 11010

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
1. Product Data: For each type of product indicated. Include construction details, materials, dimensions of individual components and profiles, and finishes.
2. Shop Drawings: Show fabrication and installation details. Indicate dimensions, weights, loadings, required clearances, method of field assembly, and components. Include plans, elevations, sections, details, and attachments to other Work.
3. Coordination Drawings: Roof plans drawn to scale and coordinating penetrations and roof-mounted items. Show the following:
   a. Size and location of roof accessories specified in this Section.
   b. Method of attaching roof accessories to roof or building structure.
   c. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Samples for Verification: For each type of exposed finish required, prepared on Samples in manufacturer's standard sizes, and of same thickness and material indicated for the Work. If finishes involve normal color or shade variations, include sample sets showing the full range of variations expected. Provide a mock-up of custom-fabricated items
5. Certification.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. NRCA: Roofing and Waterproofing Manual.
3. SMACNA: Architectural Sheet Metal Manual.
4. ASTM: A653, A729, A780, B209, B221, C920, C1036, D256, D4586, E527.
5. UL 793, 972.
6. SSPC - Paint 12
7. NFPA: 204M.
8. NAAMM.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to jobsite in original unopened containers clearly labeled with manufacturer's name and brand designation, type, class and rating as applicable.

B. Store products in approved dry area and protect from contact with soil and from exposure to the elements.

C. Handle products to prevent breakage of containers and damage to products.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL:

A. Aluminum Sheet: ASTM B 209 for alclad alloy 3005H25 or alloy and temper required to suit forming operations, with mill finish, unless otherwise indicated

B. Extruded Aluminum: ASTM B 221 alloy 6063-T52 or alloy and temper required to suit structural and finish requirements, with mill finish, unless otherwise indicated

C. Galvanized Steel Sheet: ASTM A 653 with G90 coating designation; commercial quality, unless otherwise indicated.
   1. Structural Quality: Grade 40, where indicated or as required for strength.

D. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792 with Class AZ-50 coating, structural quality, Grade 40, or as required for strength.

E. Plastic Sheet: Unless additional thickness is required for light transmittances, provide glazing plastic sheet thickness required for 40-lbf/sq. ft. external and 20-lbf/sq. ft. internal loading pressures as recommended by the manufacturer for the size and shape indicated.
   1. Polycarbonate: Thermoformable, monolithic polycarbonate sheets manufactured by the extrusion process, burglar-resistance rated per UL 972 with average impact strength of 16 ft-lbf/in. of width when tested according to ASTM D 256, Method A (Izod)

F. Insulation: Manufacturer's standard rigid or semirigid glass-fiber board of thickness indicated.

G. Wood Nailers: Not less than 1-1/2 inches thick complying with Section 06100.

H. Fasteners: Same metal as metals being fastened, or nonmagnetic stainless steel or other noncorrosive metal as recommended by manufacturer. Match finish of exposed fasteners with finish of material being fastened.
   1. Where removing exterior exposed fasteners affords access to building, provide nonremovable fastener heads.

I. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, or PVC; or flat design of foam rubber, sponge neoprene, or cork.

J. Bituminous Coating: SSPC-Paint 12, solvent-type bituminous mastic, nominally free of sulfur and containing no asbestos fibers, compounded for 15-mil dry film thickness per coating.

K. Mastic Sealant: Polyisobutylene; nonhardening, nonskinning, nondrying, nonmigrating sealant.

L. Elastomeric Sealant: Generic type recommended by unit manufacturer that is compatible with joint surfaces; ASTM C 920, Type S, Grade NS, Class 25, and Uses NT, G, A, and, as applicable to joint substrates indicated, O and in accordance with Section 07900.

M. Roofing Cement: ASTM D 4586, nonasbestos, fibrated asphalt cement designed for trowel application or other adhesive compatible with roofing system.

2.02 ROOF CURBS AND EQUIPMENT SUPPORTS:

A. General: Provide roof curbs capable of supporting superimposed live and dead loads, including equipment loads and other construction to be supported on roof curbs. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

B. Fabrication: Unless otherwise indicated or required for strength, fabricate units from minimum 0.0747-inch thick, structural-quality, hot-dip galvanized or aluminum-zinc alloy-coated steel sheet; factory primed and prepared for painting with welded or sealed mechanical corner joints.

2.03 ROOF HATCHES:

A. General: Fabricate units to withstand 40-lbf/sq. ft. external and 20-lbf/sq. ft.internal loading pressure. Frame with minimum 9-inch- high, integral-curb, double-wall construction with 1-1/2-inch insulation, formed cants and cap flashing (roofing counterflashing), with welded or sealed mechanical corner joints. Provide double-wall cover (lid) construction with 1- inch-thick insulation core. Provide gasketing and equip with corrosion-resistant or hot-dip galvanized hardware including pintle hinges, hold-open devices, interior padlock hasps, and both interior and exterior latch handles.

B. Type: Single-leaf personnel access.
   1. For Ladder Access: 30 by 36 inches.
   2. For Ship's Ladder Access: 30 by 54 inches.
      a. For Stair Access: 30 by 102 inches.

C. Type: Double leaf for equipment access.
   1. Size: 72 by 96 inches.

D. Material and Finish: Galvanized steel, baked enamel.

E. Sloping Roofs: Where slope or roof deck exceeds 1/4 inch per foot (1:48), fabricate hatch curbs with height tapered to match slope to level tops of units.

2.04 SMOKE VENTS:

A. General: Automatically operated roof vents for heat and smoke constructed to operate (open) without power source that could be interrupted during a fire. Custom fabricate units only to extent necessary to comply with indicated dimensions and other special requirements.

B. Live Load and Uplift: Unless otherwise indicated, fabricate to withstand a minimum 10-lbf/sq. ft. external live load and 30-lbf/sq. ft. uplift.

C. Regulatory Requirements: Comply with provisions of the following:
   1. UL 793, for construction and performance of automatically operated roof vents for heat and smoke
   2. NFPA 204M, for heat-and-smoke vent design constraints, operation, size, and location.\

D. Framing: Fabricate from the following materials, with manufacturer's standard welded or sealed mechanical corner joints, including cap flashing (roofing counterflashing):
   1. Material: Formed sheet or extruded aluminum or galvanized steel, at Contractor's option
      a. Finish: Baked enamel.
      b. Finish: High-performance organic coating.
   2. Unit Support: Double-wall curb construction with 1-inch insulation, of height indicated or, if not indicated, for mounting with height minimum 9 inches above roof membrane.
      a. Provide formed cants and base profile coordinated with roof type and insulation thickness.
   3. Sloping Roofs: Where slope of roof deck exceeds 1/4 inch per foot(1:48), fabricate curbs with height tapered to match slope to level tops of units.

E. Dome-Type Units: Manufacturer's standard gravity-opened, shrink-back and drop-out, acrylic or PVC sheet, dome unit for 165 deg F activation. Provide glazing system for easy replacement of activated domes and for drainage of condensation to exterior.
   1. Inner Double-Dome Color: Bronze.

2.05 SNOWGUARDS:

A. L-shaped stop-type, metal or plastic.

B. Provide in accordance with approved mock-up sample.

2.06 FINISHES, GENERAL:

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.07 ALUMINUM FINISHES:

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Conversion-Coated and Factory-Primed Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below).
   1. Organic Coating: Air-dried primer of not less than 2.0-mil0.5-mm dry film thickness.

C. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting. Below references AAMA standard for pigmented organic coating on extrusions. Color as selected by the Authority's representative.

D. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
   1. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight. Color as selected by the Authority's representative.

2.08 GALVANIZED STEEL SHEET FINISHES:

A. Surface Preparation: Clean surfaces with nonpetroleum solvent so surfaces are free of oil and other contaminants. After cleaning, apply a conversion coating suited to the organic coating to be applied over it. Clean welds, mechanical connections, and abraded areas, and apply galvanizing repair paint specified below to comply with ASTM A 780.
   1. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.

B. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-enamel finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat. Comply with paint manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

PART 3 - EXECUTION

3.01 INSTALLATION

A. General: Comply with manufacturer's written instructions. Coordinate installation of roof accessories with installation of roof deck, roof insulation, flashing, roofing membranes, penetrations, equipment, and other construction involving roof accessories to ensure that each element of the Work performs properly and that combined elements are waterproof and weather tight. Anchor roof accessories securely to supporting structural substrates so they are capable of withstanding lateral and thermal stresses, and inward and outward loading pressures

B. Install roof accessory items according to construction details of NRCA's "Roofing and Waterproofing Manual," unless otherwise indicated,

C. Separation: Separate metal from incompatible metal or corrosive substrates, including wood, by coating concealed surfaces, at locations of contact, with bituminous coating or providing other permanent separation.

D. Flange Seals: Unless otherwise indicated, set flanges of accessory units in a thick bed of roofing cement to form a seal.

E. Cap Flashing: Where required as component of accessory, install cap flashing to provide waterproof overlap with roofing or roof flashing (as counterflashing). Seal overlap with thick bead of mastic sealant.

F. Operational Units: Test-operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

G. Heat-and-Smoke Vents: Locate, install, and test according to NFPA 204M.

H. Install wood nailers in accordance with Section 06100.

I. Install sealants in accordance with Section 07900.

J. Adhere snow guards to sheetmetal roofing by approved silicone sealant as specified in Section 07900. Locate and space snow guards in accordance with manufacturer’s recommendations. Where snow guards are located on standing seams, provide approved mechanical fastenings.

3.02 CLEANING AND PROTECTION:

A. Clean exposed surfaces according to manufacturer's written instructions. Touch up damaged metal coatings.

END OF SECTION

SECTION 07815

SPRAYED FIREPROOFING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes providing sprayed fireproofing for application to structural steel.

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

1. Shop Drawings:
   a. Product data, installation instructions, and recommendations for each sprayed fireproofing product and auxiliary material, demonstrating compliance with requirements. Include written data verifying that applied thicknesses meet specified hourly fire-resistance ratings.
   b. Structural framing plans indicating the following:
      1) Surface preparation requirements required prior to fireproofing application.
      2) Extent of sprayed fireproofing for each different construction and fire-resistance rating including the following:
         a) Applicable fire-resistive design designations of inspecting and testing agency acceptable to authorities having jurisdiction.
         b) Minimum thicknesses needed to achieve required fire-resistance ratings of structural components and assemblies.
      3) Treatment of fireproofing after application.
2. Samples: Three of each type of the following:
   a. Sprayed fireproofing sample 12 inches square by 3/8 inch thick.
   b. Metal lath, anchorage devices, and accessories.
   c. In-place samples of each type of fireproofing sprayed on structural-steel elements where directed and in thickness required for specified hourly fire-resistance ratings for testing by the Engineer.
3. Quality Assurance Submittals:
   a. Qualification Data: For firms and persons specified in the Quality Assurance article to demonstrate their capabilities and experience.
   b. Code Approval: Submit research or evaluation reports of the model code organization acceptable to authorities having jurisdiction showing that sprayed fireproofing products comply with the building code.
   c. Manufacturer's certification that the sprayed fireproofing system and each product used are compatible with adhesives, primers and other surface coatings on substrates indicated.
4. Certification:

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications.
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. UL: Fire Resistance Directory, Building Materials Directory.
   3. ASTM: E84, E119, E605, E736, E759, E760, E761, E859, E937, G21.

4. AWCI: Technical Manual 12-A.

B. Fire-Test-Response Characteristics: Provide sprayed fireproofing products identical to those used in assemblies tested for the following fire-test-response characteristics by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify packages containing fireproofing with appropriate classification markings of applicable testing and inspecting agency.
   1. Fire-Resistance Ratings: As indicated by reference to fire-resistive designs listed in UL Fire Resistance Directory, or in the comparable publication of another testing and inspecting agency acceptable to authorities having jurisdiction, for fire-resistive assemblies where sprayed fireproofing serves as direct-applied protection, tested in accordance with ASTM E119.
   2. Surface-Burning Characteristics: As indicated for each sprayed fireproofing product required, tested in accordance with ASTM E84.

C. Manufacturer Qualifications: Obtain sprayed-on fireproofing system materials from a single manufacturer who evaluates and licenses installers to ensure products are properly installed.

D. Installer Qualifications: Employ an experienced installer licensed by the sprayed fireproofing manufacturer as having the necessary skill, training, experience and staff to install manufacturer's products as specified and in accordance with manufacturer's recommendations.

E. Certify that each product in the sprayed fireproofing system is compatible with adhesives, primers, and other surface coatings on substrates.

F. Provide fireproofing products containing no asbestos.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to jobsite in original unopened containers clearly labeled with manufacturer's name and brand designation, referenced specification number, type, class and ratings as applicable.

B. Store products in an approved dry area. Protect from contact with soil and from exposure to the elements. Keep products dry.

C. Handle products to prevent breakage of containers and damage to products.

D. Use materials with limited shelf life within period indicated. Discard materials whose shelf life has expired.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
   1. Application of sprayed fireproofing when temperature of substrate material or ambient temperature is lower than 40F is prohibited. Maintain temperature above 40F until fire proofing is cured and dried.
   2. Additional environmental requirements in accordance with manufacturer's recommendations.
   3. Provide ventilation in area to receive sprayed fireproofing, introducing fresh air and exhausting air continuously for 24 hours after application to maintain nontoxic, unpolluted, safe working area.

B. Coordination: Coordinate installation work to minimize need for other trades to cut into applied fireproofing.
   1. Perform application only when substrate construction and penetrating work is complete.
   2. Ensure that attachments to steel for work of other trades are complete before application of fireproofing.
   3. Immediately patch cut-away fireproofing to comply with requirements for original work.
   4. Install fireproofing prior to installation of ductwork, piping, conduits, suspended equipment and other obstructions.

PART 2 - PRODUCTS

2.01 SPRAYED CEMENTITIOUS FIREPROOFING:

A. General: Factory-mixed, dry formulation listed in the UL Building Materials Directory or by another testing and inspecting agency acceptable to authorities having jurisdiction, consisting of portland cement, additives and mineral aggregates mixed with water at project site to form a slurry for pumping and dispersal by compressed air.

B. Physical Properties: Minimum values, unless otherwise indicated or higher values required to attain designated fire-resistance ratings, measured per standard test methods referenced with each property listed below:
   1. Dry Density: 15 pcf for average and individual densities regardless of density indicated in referenced fire-resistive design, or greater if required to attain fire-resistance ratings indicated, as determined per ASTM E605 or Appendix A, Alternate Method for Density Determination, of AWCI Technical Manual 12-A.
   2. Bond Strength: 300 psf as determined in accordance with ASTM E736.
   3. Compressive Strength: 1400 psf as determined in accordance with ASTM E761.
   4. Surface-Burning Characteristics: Provide materials with the following maximum surface-burning characteristics as determined in accordance with ASTM E84.
      a. Flame spread: 10.
      b. Smoke developed: 0.
   5. Corrosion Resistance: No evidence of corrosion as determined in accordance with ASTM E937.
   6. Deflection: No cracking, spalling, delamination or the like as determined in accordance with ASTM E759.
   7. Effect of Impact on Bonding: No cracking, spalling, delamination or the like as determined in accordance with ASTM E760.
   8. Air Erosion: Maximum weight loss of 0.0025 gram per sq. ft. in 24 hours as determined per ASTM E859.
   9. Fungal Resistance: No observed growth on specimens in accordance with ASTM G21.
   10. Thickness: Provide minimum average thickness required for fire-resistive design indicated according to the following criteria, but not less than 3/8 inch, as determined per ASTM E605.
      a. Where the referenced fire-resistive design lists a thickness of one inch or greater, the minimum allowable individual sprayed-on fireproofing thickness is the design thickness minus 1/4 inch.
      b. Where the referenced fire-resistive design lists a thickness of less than one inch but more than 3/8 inch, the minimum allowable individual sprayed-on fireproofing thickness is the greater of 3/8 inch or 75 percent of the design thickness.

2.02 AUXILIARY FIREPROOFING MATERIALS

A. General: Provide auxiliary fireproofing materials that are acceptable to primary material manufacturer, are compatible with sprayed fireproofing products and substrates and are approved by UL or another testing and inspecting agency acceptable to authorities having jurisdiction for use in the fire-resistive designs indicated.

B. Substrate Primers: Unless fireproofing manufacturer recommends against priming, provide primer that complies with one or more of the following requirements:
   1. Bond strength complies with requirements specified in UL Fire Resistance Directory for coating materials based on a series of bond tests in accordance with ASTM E736.
   2. Primer is identical to those used in assemblies tested for the fire-test-response characteristics of sprayed-on fireproofing, in accordance with ASTM E119, by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

C. Adhesive for Bonding Fireproofing: Product approved by manufacturer of sprayed-on fireproofing.

D. Metal Lath, Anchorage Devices and Accessories: Use only stainless steel, zinc alloy or hot-dip galvanized types as recommended by manufacturer for applications indicated.

E. Topcoats: Type as recommended by manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates with installer present to determine that they are in satisfactory condition to receive sprayed-on fireproofing. A substrate is in satisfactory condition if it complies with the following:
   1. Substrate is free of oil, grease, rolling compounds, incompatible primers, loose mill scale, dirt, or other foreign substances capable of impairing bond of fireproofing with substrate under conditions of normal use or fire exposure.
   2. Objects penetrating fireproofing, including clips, hangers, support sleeves, and similar items, are securely attached to substrate.
   3. Substrate is not obstructed by ducts, piping, equipment, and other suspended construction that will interfere with applying the fireproofing.

B. Conduct tests according to sprayed fireproofing manufacturer's recommendations to verify that substrates are free of oil, rolling compounds, and other substances capable of interfering with bond where there is any doubt as to their presence.

C. Do not proceed with installation of fireproofing until unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Clean substrates of substances that could impair bond of fireproofing, including oil, grease, rolling compounds, incompatible primers, and loose mill scale.

B. Prime substrates unless fireproofing manufacturer recommends against priming or unless compatible shop primer acceptable to fireproofing manufacturer has been applied and is in satisfactory condition to receive fireproofing.

C. Cover other work subject to damage from fall-out or overspray of fireproofing materials during application. Provide temporary enclosure as required to confine spraying operations, protect the environment and ensure maintaining adequate ambient conditions for optimal temperature and ventilation.

D. Install metal lath, anchorage devices and accessories where necessary to comply with tested fire resistance rating and with recommendations of fireproofing manufacturer for conditions of exposure and intended use. Securely attach lath to substrate in position required for support and reinforcement of fireproofing.

3.03 APPLICATION:

A. Comply with fireproofing manufacturer's instructions as applicable to the particular conditions of installation and as required to achieve fire-resistance ratings indicated.

B. Match fireproofing design and assemblies per UL or other testing and inspecting agency acceptable to authorities having jurisdiction. Apply fireproofing in thicknesses indicated for each area in approved shop drawings.

C. Coat substrate with adhesive prior to applying fireproofing where required to achieve fire-resistance rating or as recommended by fireproofing manufacturer for material and application indicated.

D. Extend fireproofing in full thickness over entire area of each substrate to be protected. Unless otherwise recommended by fireproofing manufacturer, install body of fireproof covering in a single course.

E. Apply fireproofing materials by sprayed-on method to maximum extent possible. Following the spraying operation in each area, complete the coverage by trowel application or other placement method recommended by manufacturer.

F. Where sealers are used, apply products that are tinted to differentiate them from the sprayed-on fireproofing over which they are applied.

3.04 CLEANING, CURING, REPAIR, AND PROTECTION:

A. Cleaning: Immediately after completing spraying operations in each containable area, remove material over-spray and fall-out from surfaces of other construction and clean exposed surfaces to remove evidence of soiling.

B. Cure cementitious fireproofing materials according to fireproofing manufacturer's recommendations to prevent premature drying.

C. Protect fireproofing, according to advice of fireproofing manufacturer and installer, from damage resulting from construction operations or other causes so that fireproofing will be without damage or deterioration at time of final acceptance.

D. As installation of other construction proceeds, inspect fireproofing and patch any areas where fireproofing was removed or damaged.

E. Repair or replace work that has not been successfully protected.

END OF SECTION

SECTION 07841
FIRESTOPPING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This Section perimeter fire containment systems and specifies through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies:
   1. Floors.
   2. Roofs.
   3. Walls and partitions.
   4. Construction enclosing compartmentalized areas.
   5. Smoke barriers

B. Related Work Specified Elsewhere:
   1. Cast-in-Place Structural Concrete: Section 03300 for construction of openings in concrete slabs and walls.
   2. Division 15 Sections specifying duct and piping penetrations.
   3. Division 16 Sections specifying cable and conduit penetrations.

1.02 PERFORMANCE REQUIREMENTS:

A. General: For the following constructions, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of assembly penetrated.
   1. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
   2. Fire-resistance-rated floor assemblies
   3. Fire-resistance-rated roof assemblies.

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B. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, as determined per ASTM E 814, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.

C. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, as determined per ASTM E 814, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
   1. Penetrations located outside wall cavities.
   2. Penetrations located outside fire-resistive shaft enclosures.
   3. Penetrations located in construction containing fire-protection-rated openings.
   4. Penetrating items larger than 4-inch diameter nominal pipe or 16 sq. in. in overall cross-sectional area.

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that after curing do not deteriorate when exposed to these conditions both during and after construction.
   1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
   2. For floor penetrations with annular spaces exceeding 4 inches in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved either by installing floor plates or by other means.

3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.

E. For through-penetration firestop systems exposed to view, provide products with flame-spread ratings of less than 25 and smoke-developed ratings of less than 450, as determined per ASTM E 84.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the Special Conditions and with the additional requirements as specified for each:

B. Product Data: For each type of through-penetration firestop system product indicated.

C. Shop Drawings: For each through-penetration firestop system, show each kind of construction condition penetrated, relationships to adjoining construction, and kind of penetrating item. Include firestop design designation of testing and inspecting agency acceptable to authorities having jurisdiction that evidences compliance with requirements for each condition indicated.
1. Submit documentation, including illustrations, from a qualified testing and inspecting agency that is applicable to each through-penetration firestop system configuration for construction and penetrating items.

D. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

E. Certification: Signed by manufacturers of through-penetration firestop system products certifying that products furnished comply with requirements.

1.04 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. ASTM E 84, E 814.
3. UL - 1479.

B. Installer Qualifications: An experienced installer who has completed through-penetration firestop systems similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

C. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

D. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in "Performance Requirements" Article:
1. Through-penetration firestop systems are identical to those tested per ASTM E 814. Provide rated systems complying with the following requirements:.
   a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
   b. Through-penetration firestop systems correspond to UL in Fire Resistance Directory reference to through-penetration firestop system designations listed by the following:

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1.05 DELIVERY, STORAGE, AND HANDLING:

A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.

B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.06 PROJECT CONDITIONS:

A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.07 COORDINATION:

A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.

B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.

C. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until the Engineer has examined each installation.

PART 2 - PRODUCTS

2.01 FIRESTOPPING, GENERAL:

A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.

B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:

1. Permanent forming/damming/backing materials, including the following:
    a. Slag-/rock-wool-fiber insulation.
    b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
    c. Fire-rated form board.
    d. Fillers for sealants.
2. Temporary forming materials.

3. Substrate primers.
4. Collars.
5. Steel sleeves.

2.02 FILL MATERIALS:

A. General: Provide through-penetration firestop systems containing the types of fill materials indicated in the Through-Penetration Firestop System Schedule at the end of Part 3 by reference to the types of materials described in this Article. Fill materials are those referred to in directories of the referenced testing and inspecting agencies as fill, void, or cavity materials.

B. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer metallic sleeve lined with an intumescent strip, a radial extended flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

C. Latex Sealants: Single-component latex formulations that after cure do not re-emulsify during exposure to moisture

D. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

E. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced elastomeric sheet bonded to galvanized steel sheet.

F. Intumescent Putties: Nonhardening dielectric, water-resistant putties containing no solvents, inorganic fibers, or silicone compounds.

G. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.

H. Mortars: Prepackaged, dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

I. Pillows/Bags: Reusable, heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.

J. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

K. Silicone Sealants: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:
1. Grade for Horizontal Surfaces: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces.
2. Grade for Vertical Surfaces: Nonsag formulation for openings in vertical and other surfaces.

2.03 PERIMETER FIRE-CONTAINMENT SYSTEMS:

A. Where indicated for gaps between the perimeter edge of fire-resistance-rated floor assemblies and non-fire-resistance-rated exterior curtain walls, provide a perimeter fire-containment system with the fire-test response characteristics indicated, as determined by

testing identical systems per UBC Standard 26-9 and UL 2079 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.

PART 3 - EXECUTION

3.01 EXAMINATION:

A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 PREPARATION:

A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
   1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
   2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
   3. Remove laitance and form-release agents from concrete.

B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.03 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION:

A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

C. Install fill materials for firestop systems by proven techniques to produce the following results:
   1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
   2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
   3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 FIELD QUALITY CONTROL:

A. Where deficiencies are found, repair or replace through-penetration firestop systems so they comply with requirements.

3.05 IDENTIFICATION:

A. In areas not exposed to public view, identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
   1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb."

3.06 CLEANING AND PROTECTION:

A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

3.07 THROUGH-PENETRATION FIRESTOP SYSTEM SCHEDULE:

A. Where UL-classified systems are indicated, they refer to the alpha-alpha-numeric designations listed in UL's "Fire Resistance Directory" under product Category XHEZ.

B. Firestop Systems for Metallic and Non-metallic Conduit, Tubing, Sleeves, Cable Trays and Cables:
   1. UL-1479: Fire rated for 3 hours.
   2. Type of fill materials: One or more of the following:
      a. Silicone sealant.
      b. Intumescent putty.
      c. Silicone foam.

C. Firestop Systems for Insulated Pipes: Comply with the following:
   1. UL- 1479: CAJ 5087.
   2. Type of Fill Materials: Intumescent putty.

D. Firestop Systems for Miscellaneous Mechanical Penetrations: Comply with the following:
   1. UL- 1479: CAS 8033.
   2. Type of Fill Materials: Mortar.

E. Firestop Systems for Ductwork: Comply with the following:
   1. UL- 1479: WJ7007.
   2. Type of Fill Materials: Intumescent sealant.

END OF SECTION

SECTION 07900

SEALS AND SEALANTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing compression seals and sealants not specified elsewhere.

B. Related Work Specified Elsewhere:
1. Rabbet for compression seal in granite edging: Section 04415.
2. Expansion joint cover assemblies and systems: Sections 05810 and 05811.
3. Sealant for metal thresholds: Section 08710.
4. Glazing sealant: Section 08800.
5. Acoustical sealant: Section 09255.
6. Ceramic tile sealant: Section 09320.
7. Caulk for painting preparation: Section 09920.
8. Paver tile sealant: Section 09340.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. ASTM: C920, C1193, D412, D1752, D2628.

B. Manufacturer Qualification:
1. General: Provide the products of established manufacturers. Insofar as possible, provide products from a single manufacturer.
2. Sealant color-selection capability: Have color-selection capability resolved early in the submittals process to prevent delay of the work.
   a. Where sealants are exposed, provide products of a manufacturer who can match the colors of adjacent materials by either having an acceptable range of standard colors or by factory blending custom colors as acceptable to the Engineer and at no additional cost to the Authority.
   b. Where a manufacturer's colors are insufficient for proper color-match, use acceptable colors from another acceptable manufacturer.
3. On-site representation: Use only a sealant manufacturer who has a local, knowledgeable representative who can visit the project site prior to construction and at least twice during sealant installation to observe conditions and recommend solutions at no additional cost to the Authority.

C. Design Criteria:
1. Designed width of exterior joints: Joint widths indicated on drawings are shown at their designed width. This is measured when the joint would be at the average air temperature for the year, which is approximately 50F, based on an average minimum air temperature of zero degrees F and an average maximum air temperature of 100F.
2. Designed width of interior joints: Joint widths indicated on the drawings are shown at their designed width at 50F.
3. Joint width at time of seal or sealant application: Make joint widths at time of installation never less than the calculated width, which at 0 degrees F is 25 percent wider than the designed width and at 100F is 25 percent narrower than the designed width for exterior joints and 1-1/2 percent smaller than the designed width for each

degree the ambient temperature exceeds 50F, and 1-1/2 percent larger than the designed width for each degree the ambient temperature is less than 50F.

a. It is recommended that seals and sealant be installed when the average daily air temperature is 50 degrees F plus or minus five degrees, when joint should be at its designed width.
b. If joints are less than the calculated width at the time of proposed installation, take corrective action, which may include saw cutting of joint or other remedial measures approved by the Engineer and by the seal or sealant manufacturer.
c. If the joint depth is not sufficient for the designed width of the joint, sealant and backup, cut out the joint to the required depth for the sealant and backup.
d. Perform cutting and remedial measures that are acceptable to the Engineer. Cost of cutting and remedial measures are at no additional cost to the Authority.

4. Joint size and sealant size: Except as otherwise indicated, make sealant at least 1/4-inch wide x 1/4-inch deep. In joints 3/8 inches wide, make sealant 1/4-inch deep. In joints wider than 3/8-inch and up to 1-inch wide, make sealant depth 1/2 of the joint width. For joints wider than 1 inch, make sealant depth as recommended by the sealant manufacturer.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

1. Samples:
   a. Material samples: Four of each type of the following materials used in the work:
      1) Compression seals: 12 inches long, plus each factory-made corner unit.
      2) Sealant and lubricant-adhesive: Half-pint containers.
      3) Sealant colors: Fully cured beads of each color used, each six inches long.
      4) Backup material: 12 inches long.
      5) Joint filler: 12 inches long.
      6) Color chips: 12 inches long, one for each color used in the work.
   b. Demonstration samples: Make demonstration installation of each seal and sealant installation type and color. Use approved materials, installed and cured as required. Remove demonstration samples as directed. Perform testing on sealant demonstration samples as specified under Field Testing.
2. Shop Drawings:
   a. General: Submit manufacturers technical product data for each product proposed to be used, together with standard and custom color-selection samples.
   b. Compression seals: Detail correct size and placement of each type and size of compression seal in its joint.
   c. Test results: Inspection and adhesion test results performed by sealant manufacturer.
3. Certification by each manufacturer that the products provided will perform as required and will not stain adjacent materials.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products to jobsite in original unopened containers clearly marked with manufacturer's name and brand designation, referenced specification number, type and class as applicable.

B. Store products in approved dry area and protect from contact with soil and from exposure to the elements. Keep products dry.

C. Handle products to prevent breakage of containers and damage to products.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
1. Application of seals or sealants, including their related products, when ambient temperature is lower than 40F or when there is ice, frost or dampness visible on surfaces to be sealed is prohibited.
2. Comply with manufacturer's environmental recommendation.

PART 2 - PRODUCTS

2.01 COMPRESSION-SEAL MATERIALS:

A. Preformed compression seals: ASTM D2628, rectangular design unless otherwise shown.
1. Width: Size compression seals for full amount of joint movement as required, plus the thickness of the compressed seal as recommended by the manufacturer.
2. Corners: Provide factory pre-molded or factory pre-cut and welded corner units for angular changes in direction, vertically as well as horizontally, including 30, 60, 45, 90, 120, 135, and 150 degrees as required by joint location.

B. Lubricant-adhesive, general: One-part moisture-curing polyurethane as recommended by compression seal manufacturer, with the following additional requirements:

Physical Property	Requirement	ASTM Test Method
Average weight per gallon	8.00 pounds plus-or-minus 10 percent	-
Solids content	65 - 74 percent by weight	-
Adhesive	Fluid from 5F to 120F	-
Film strength	1200 psi, minimum	D412
Elongation	250 percent	D412

C. Lubricant-adhesive for compression seal in granite: Same as above, but also tested for nonstaining over a three-month period on samples of granite to be used.

2.02 SEALANT AND ACCESSORIES:

A. General: Provide joint sealant, backup rod, primer, and other related materials that are compatible with one another and with the joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on field experience and submitted test reports.

B. Sealant (Polyurethane): Polyurethane-based or epoxidized polyurethane based, multi-part elastomeric sealant, ASTM C920, Type M (multi-component), Class 25 (withstands an increase or decrease of 25 percent of the joint width) as follows:
   1. For joints in horizontal surfaces: Grade P (pourable or self-leveling), Uses T (traffic areas), M (on masonry) or O (other than standard substrates).
   2. For joints in sloped surfaces: Grade NS (nonsag), Uses T (traffic areas), M (on masonry) or O (other than standard substrates).
   3. For joints in overhead and vertical surfaces: Grade NS (nonsag), Uses NT (nontraffic areas), M (on masonry), A (on aluminum), or O (other than standard substrates).

C. Primer: Colorless, nonstaining liquid material of types suited to each substrate surface, as tested and recommended in writing by the manufacturer of each sealant to be used.

D. Backup Rod: Preformed, compressible, resilient, non-waxed, non-extruding, nonstaining, closed-cell rod stock of polyethylene or polyethylene-jacketed foam which will maintain a uniform round or oval cross-sectional shape when compressed into the joint.
   1. Select backup rods as recommended by the manufacturer of each sealant to be used; compatible with joint substrates, sealants, primers, and other joint fillers; that will not bond with sealants and primers; and are approved for applications indicated based on field experience and laboratory testing.
   2. Select backup rod of the sizes and shapes to suit the various conditions and at about 30 percent wider than the joint width.
      a. Where depth of joint is too shallow for round backup rod use 1/2-round backup rod, factory manufactured with cut surface fused by heat process so that it cannot release gas.
      b. Where depth is too shallow for 1/2-round rod, use bond breaker tape.

E. Bond-Breaker Tape: Polyethylene tape, as recommended by the manufacturer of each sealant to be used, for preventing sealant from adhering to joint-filler materials or joint surfaces at back of joint where such adhesion would promote sealant failure, or result in less than optimal performance. Provide tape sized properly for the joint. Provide self-adhesive tape where applicable.

F. Cleaning Agent: Joint cleaning compound tested and recommended in writing by sealant manufacturer for cleaning joint surfaces before priming. Use only a cleaner which is nonstaining, non-harmful to masonry, does not leave oily residues, and does not have a detrimental effect on adhesion or in-service performance.

G. Weep Tubes: Vinyl tubing, 3/8-inch diameter.

H. Masking Tape: Nonstaining, nonabsorbent type, compatible with joint sealants and to surfaces adjacent to joints. Use only a masking tape which will easily come off entirely, including adhesive.

I. Joint Filler for Sealant Joints : Nonstaining joint filler compatible with backer rod and sealant:
   1. Sponge rubber: Preformed strips complying with ASTM D1752 Type I.

J. Joint Filler for Pavers and Walkways: Nonstaining joint filler compatible with backer rod and sealant; one of the following. Where filler is not shown covered by sealant, see Section 03300:
   1. Cork: Preformed strips complying with ASTM D1752 Type II.

2. Self-expanding cork: Preformed strips complying with ASTM D1752 Type III.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION:

A. Inspection:
1. With installer present, examine joints for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting the performance of joint seals and sealants.
2. Have sealant manufacturer's representative visit the site and review the project joint conditions and details for sealant work of this Project and perform adhesion testing. Have sealant manufacturer representative report to the Engineer in writing the results of his inspections and tests.
3. Do not proceed with work of this section until unsatisfactory conditions have been corrected.

B. Preparation: Comply with the recommendations of ASTM C1193 and the following:
1. Cleaning:
a. Clean joint surfaces receiving seals or sealants. Ensure that they are sound, smooth, clean, dry, and free of foreign substances and contaminants, including curing compounds and release agents.
b. Remove factory or field-applied coatings that will be detrimental to adhesion of seals, sealants or primers.

2. Masking: Use masking where required to prevent contact of sealant and primers with adjoining surfaces that otherwise would be stained or damaged by such contact or by cleaning methods required to remove sealant or primer smears.

C. Priming: Unless sealant manufacturer specifically recommends in writing against priming, apply primer to prepared surfaces that will receive sealant. Apply primer on clean, dry surfaces, and prior to installation of backup rod. Completely wet both inner faces of the joint with primer.

D. Backup rod: Install backup rod in joints (after primer is dry) to provide backup and give proper shape for sealant bead. Where there is insufficient joint depth for backup rod, install half-round backup rod or bond breaker tape as approved in lieu of backup rod.
1. Proper cross-sectional shape for sealant bead is a very slight hourglass shape with back and front faces having slight concave curvature, unless indicated otherwise. Use special blunt T-shaped tool or roller to install backup rod to the proper and uniform depth required for the sealant.
2. Install size of backup rod that will provide approximately 30 percent compression.
3. Do not stretch, twist, braid, puncture, or tear backup rod. A broken surface will emit gas (out-gassing) that blisters the installed sealant, thereby requiring complete removal and reinstallation of primer, backup rod, and sealant.
4. Tightly butt backup rods at joints and intersections. At outside corners, provide sufficient length of backer rod so that rod can be bent around corner rather than cut at corner, so that out-gassing will not occur.

E. Bond breaker tape: Where space for a backup rod is inadequate, use bond breaker tape to prevent three-sided adhesion. Install bond breaker tape smoothly over back of joints so that sealant adheres to the sides of joint but not to the back of joint.

3.02 INSTALLATION:

A. Compression Seals:
   1. If adjacent surfaces are to receive waterproofing, install compression seals prior to application of waterproofing.
   2. Prime interfaces, edges and corners of joints as necessary.
   3. Prime and lubricate joints by coating both sides of joint with lubricant-adhesive to wet-film thickness of 20 mils.
   4. While lubricant-adhesive is still wet, install compression seals to depth shown.
   5. Recess exposed edges slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.
   6. Bond ends together with materials and methods recommended by manufacturer to ensure continuous watertight and airtight performance. Where factory pre-molded or pre-welded corner units are unavailable, miter-cut and bond ends at corners.

B. Sealant:
   1. Comply with ASTM C1193 and with manufacturer's recommendations, except where more stringent requirements are shown or specified.
   2. Set joint-filler units at depth or position in joint as shown to coordinate with other work, including installation of bond breakers, backer rods and sealants. Do not leave voids or gaps between ends of joint-filler units.
   3. Install back-up material, except where shown to be omitted or recommended to be omitted by sealant manufacturer for application used.
   4. Install bond-breaker tape where shown and where recommended by manufacturer to ensure that sealants will perform as intended.
   5. Employ installation techniques which will ensure that sealants are deposited in uniform, continuous ribbons without gaps or air pockets, with complete wetting of joint bond surfaces equally on opposite sides.
      a. Except as otherwise shown, fill sealant rabbet to slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between horizontal surface and vertical surface, fill joint to form slight cove, so that joint will not trap moisture and dirt.
      b. Fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep nor less than 1/4-inch deep.
      c. Ensure that temperature of sealant, as well as of substrates, at time of sealant application, is as recommended by sealant manufacturer and as specified herein. Apply sealant at optimum time after primer application.
      d. Remove masking immediately after tooling of sealant and before sealant face starts to skin over. Do not cause dislocation of sealant, or migration of sealant to adjacent surfaces when removing masking tape.
   6. Spillage: Do not allow sealants or compounds to overflow from confines of joints, to spill onto adjoining work or to migrate into voids of exposed finishes. If spillage occurs, eliminate evidence of spillage to the Engineer’s satisfaction.
   7. Seal joints in granite work with sealant, except granite-paving joints and pylon-apron joints that are shown to be grouted. Ensure joint depths of at least 3/4 inch before placing backup. If necessary, rake-out joints to a minimum depth of 3/4 inch.
   8. Weep Holes: Install weep tubes, sloping to expel water, where required to allow free drainage of hollow spaces. Where so shown, install tubes through sealant and backing to ensure an unobstructed drainage path. Do not seal over weep holes provided by other trades.

3.03 CURING AND PROTECTING:

A. Cure sealants in compliance with manufacturer's recommendations, to obtain high early bond strength, internal cohesive strength and surface durability.

B. Cure and protect joint sealers during construction period, so that they will be without deterioration, soiling or damage, other than normal wear and weathering, at time of final acceptance.

C. Cure and protect sealants so as to minimize increases in modulus of elasticity and other accelerated aging effects.

D. Replace or restore sealants damaged or deteriorated during construction and from testing as directed. Cut out or remove damaged sealant immediately and properly prepare and reseal joint with new materials to produce sealant installation with repaired areas indistinguishable from other work.

3.04 FIELD TESTING:

A. Sealant: Field test cured sealant installations in the presence of and where directed by the Engineer. Test each type of joint sealant for adhesion to joint substrates by hand-pull method as follows:

1. Make knife cuts as follows: A transverse cut from one side of joint to the other, followed by parallel cuts approximately 2 inches long at each side of joint and meeting the transverse cut at the end of the 2-inch cuts. Place a mark 1 inch from the top of 2-inch piece.
2. Use fingers to grasp the 2-inch piece of sealant just above the 1-inch mark; pull firmly away at a 90-degree angle while holding a ruler along side of sealant; pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than the distance equaling the specified maximum movement capability in extension; hold this position for 10 seconds.
3. Report whether or not the sealant in joint (connected to pulled-out portion) failed to adhere to joint substrates or failed cohesively or adhesively. Include data on pull distance used to test each type of sealant and joint substrate.
4. Sealants not evidencing adhesive failure from testing, in absence of other indications of noncompliance with requirements, will be considered acceptable, subject to certification of design and performance criteria by the manufacturer.
5. Make a minimum of 10 such tests unless otherwise directed by the Engineer. Submit report of testing to the Engineer.

3.05 CLEANING:

A. Immediately clean off excess primers, drippings, sealants and sealant smears as work progresses, using methods and with cleaning materials approved by manufacturer of each joint primer and sealant and by manufacturers of materials where joints occur.

B. Use only materials and methods acceptable to the Engineer.

END OF SECTION