Vegetated Roof Specification

Thermoplastic Membrane

[HG 2220] Semi-Intensive Native Prairie System

September 10, 2018

SECTION 07 33 63
VEGETATED ROOF ASSEMBLIES – THERMOPLASTIC

PART 1 GENERAL

I) SUMMARY

A) Furnish and install a completed Semi-Intensive vegetated roof; including, but not limited to: substrate preparation, air, thermal and/or vapor barriers, rigid insulation, cover board, Electronic Leak Detection (ELD), thermoplastic membrane system, flashings, sealants & adhesives, rot and pathogen protective fleece or, rot and pathogen resistant filter fabric, drainage and/or retention component, pavers and/or tiles on pedestals, vegetated roof growing media and vegetation. This section should be completed in coordination with Section 07 72 00 Roof Accessories and Section 07 59 00 Electronic Leak Detection (ELD), to maintain the total system warranty.

II) RELATED TRADES

A) Section 02 40 00 Demolition
B) Section 03 30 00 Concrete
C) Section 04 00 00 Masonry
D) Section 06 00 00 Carpentry
E) Section 07 60 00 Sheet Metal
F) Section 07 72 00 Roofing Accessories
G) Section 07 90 00 Caulking & Sealants
H) Section 22 00 00 Plumbing
I) Section 26 00 00 Electrical
J) Section 32 84 00 Landscape Irrigation
K) Section 32 90 00 Landscaping

III) REFERENCES

A) ANSI: American National Standards Institute www.ansi.org
B) ANLA: American Nursery and Landscape Association www.anla.org
C) ASTM: American Society of Testing Materials www.astm.org
D) EN-ISO: International Organization for Standardization
E) FLL (German): Guidelines for the Planning, Execution and Upkeep of Green-roof sites
F) MSA: Methods of Soil Analysis, American Society of Agronomy
G) RCSTP: Recommended Chemical Soil Testing Procedures
H) TMECC: Test Methods for the Examination of Composting and Compost
I) OSHA: Occupational Safety and Health Administration
J) Factory Mutual Insurance Co. 1-35 Green Roof Systems
K) USGBC: US Green Building Council,
    1) Leadership in Energy and Environmental Design LEED Reference Guide, Version 3.0
    2) USGBC Project Calculation Spreadsheet. www.usgbc.org.
L) Sustainable Sites Initiative
    1) SITES Rating System, version 2
    2) SITES v2 Rating Scorecard, www.sustainablesites.org

IV) DEFINITIONS

A) Biological Soil Fertility Amendments: Bio-stimulants and bio-fertilizers added to growth media to enhance, stimulate and feed microorganism populations and increase biological function of the growth media.
B) Captured Water: Water that is retained in the drainage layer of a Vegetated Roof Assembly after new water additions have ceased and that cannot escape the roof except through evaporation or plant transpiration.
C) Electronic Leak Detection (ELD): An electric leak location technique that relies on the electrical conductivity of the cover material (moist media) and electrical insulating properties of the waterproofing membrane. The compatibility of ELD with a specific waterproofing system must be established in advance by the vegetated roof provider.

D) Finish Elevation: Elevation of finished growing media surface of planting area.
E) Planting Area: Areas to be planted.
F) Plant, Plants, Plant Material: Vegetation in general, ornamental grasses, or herbaceous vegetation.
G) Greenformation®: A customizable maintenance service plan provided by a responsible service crew under the company direction of AD Greenroof LLC.
H) Growth Media: Lightweight soil mixture that promotes good growing conditions for specific varieties of plants.
I) Soil Consultant: Provider of products, information and rates of biological soil fertility amendments and testing laboratory coordinator for the project. Soil consultant to be approved by Hanging Gardens, LLC (www.hanging-gardens.com).
J) Vegetated Roof Installer: A pre certified vegetated roof installer with appropriate experience approved by the Total System Provider to maintain warranty.
K) Total System Provider: Single-source company providing and/or approving all materials including vegetated roof and waterproofing components required for installation who is responsible for coordination, inspection and offering long-term support through offering a total system warranty. This company shall be Hanging Gardens
L) Waterproofing Installer: Company installing the waterproofing system and in some instances components in the vegetated roofing system. Installer to be approved by Total System Provider to maintain warranty (Optional: For Total System Warranty Clients).
M) Maintenance Contractor: The pre-approved entity contracted by building owner to ensure maintenance on the system is carried out through specified timeframe. Entity and contract must be pre-approved by Total System Provider prior to signing. This entity may be the Vegetated Roof Installer.

V) QUALIFICATIONS

A) Only a contractor approved and licensed by the Total System Provider shall install the waterproofing system. Thermoplastic membrane components and all other vegetated roofing components shall be procured through the same firm to insure single-source responsibility. An independent laboratory may test materials for compliance with published physical properties and these specifications.

VI) SUBMITTALS

A) Completed Dead Load Worksheet for each Vegetated Roof System profile (ASTM E2397)
    1) Submit Total System Provider's written approval or license for contractors for waterproofing membrane and vegetated roofing system.
B) Submit most recent copy of Total System Provider's literature applicable to products and specifications to be used, as specified herein, including applicable flashing details.
C) Product Data Sheets: For each component within the Vegetated Roofing System
D) Samples for Verification: For each of the following components of Vegetated Roof Assembly:
    1) Submit three sheet samples approximately 6 x 6 inches or alternately 3 units that are representative of the following products:
        (a) Waterproofing System
            (i) PVC, Polyvinyl Chloride
        (b) Membrane Flashing and Termination Bar
        (c) Transition Flashing
        (d) Insulation
        (e) Cover Board
        (f) Protection Fleece
        (g) Drainage
        (h) Drainage/Retention Board
        (i) Filter Fleece
        (j) Edge Restraints
        (k) Pavers: Send finish options for architect/owner to determine exact finish. Note on samples if certain finishes/types would include an increase in cost from original bid. Samples should be in approximately 2" x 2" blocks. Also include product data stating actual versus nominal dimensions of each paver type.

(l) Pedestals: Send a complete pedestal assembly with slope adjusting components (if applicable) along with shims and spacer tab.

2) Growth Media: 1-quart volume of each growth media specified, in sealed plastic bags labeled with content and source. Each sample shall be typical of the lots of growing media to be furnished. Provide an accurate representation of texture and composition.

E) Product Test Reports: For each growth media, including complete analysis coordinated and approved through Hanging Gardens' approved testing facility, demonstrating compliance with specified requirements.

F) Electronic Leak Detection (ELD) Shop Drawings:
1) Completed Diagram of proposed system showing complete monitored area, rooftop structures and equipment, and roof penetrations for building utilities and services. Show location of membrane leak detection system conductor cable, measurement grid, and contact boxes.

G) Electronic Leak Detection (ELD) Quality Control Reports:
1) Diagram of proposed system showing complete monitored area, rooftop structures and equipment, and roof penetrations for building utilities and services. Show location of membrane leak detection system conductor cable, measurement grid, and contact boxes.

H) Maintenance Data: Greenformation® plan including procedures for inspection and care of vegetated roof assembly and plants during a calendar year. Contact and submit to AD Greenroof, LLC before start of required warranty and maintenance periods. (http://adgreenroof.com/2013/01/connected-generation/)

I) ELD (Electronic Leak Detection) Closeout Submittals:
1) Digital drawings, photographic documentation, and written report detailing installed location of components of membrane leak detection system.

J) Warranty: Sample of [5] [10] [15] [20] year warranty from the Total System Provider.

VII) QUALITY ASSURANCE

A) Waterproofing Installer Qualifications: The contractor and his personnel shall be currently approved by Hanging Gardens and have been certified through Hanging Gardens' training program are to apply the waterproofing system.
1) The contractor shall employ an Electronic Leak Detection (ELD) Service to survey the completed membrane application. The Total System Provider shall approve the surveyor, and:
(a) Integrate layout of membrane leak detection system with rooftop structures and equipment and roof penetrations for building utilities and services to ensure functionality of system
(b) Coordinate membrane leak detection system with work of other Sections to prevent grounding out of leak detection system.

B) Vegetated Roof Installer Qualifications: A qualified vegetated roof assembly Installer approved, authorized, or licensed by Hanging Gardens, whose work has resulted in successful establishment of vegetated roofs.
1) Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
2) Professional Membership: Installer shall be a member in good standing of the National Association of Landscape Professionals.
3) Personnel Certifications: Installer's field supervisor and personnel assigned to the work shall have certification in both of the following categories from Green Roofs for Healthy Cities:
(a) Green Roof Professional (GRP)
4) Provide a list of at least 3 projects, satisfactorily completed within the past 5 years, of similar scope and complexity to this project.
5) Installer must provide at time of proposal submittal a general liability insurance certificate showing $1,000,000 in coverage.
6) The contractor shall employ an ELD (Electronic Leak Detection) Service to survey the completed membrane application. The System supplier shall approve the surveyor.

C) Source Limitations: All vegetated roof assembly components including but not limited to growth media, walkway pavers and accessories are to be sourced or approved by the Total System Provider.

D) Pre-installation Conference: Conduct conference at project site.
1) After award of Contract and prior to the commencement of the Work of this Section, schedule and conduct meeting to discuss the Work of this Section and to coordinate with related work.

Coordinate with pre-construction meeting specified in Section (xxxxxx). Convene pre-construction meeting to comply with requirements of Division 1 and as follows:

(a) General Contractor to notify all attendees at least two weeks prior to the conference.
(b) Require attendance of parties directly affecting Work of this Section, including, but not limited to: Owner, Contractor, Architect, System Provider, System Installer, Roofing Membrane Provider, Roofing Membrane Installer and Plumbing Installers.
(c) Review methods and procedures related to installation and operation of Work of this Section, including coordination with related Work.
(d) Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.

VIII) DELIVERY, STORAGE, AND HANDLING

A) Packaged Materials:
1) Contractor to designate Project Coordinator to be responsible for coordinating all shipments with the Total System Provider, Project Coordinator to alert Total System Provider a minimum of 3 weeks prior to delivery to ensure availability of product, additional lead time may be required for certain products or plantings, reference Total System Provider's Terms and Conditions for exact lead times.
2) Store materials under cover and elevated above ground, out of direct sunlight.
3) Store roll material lying down and on pallets. Fully protect from moisture and direct sunlight exposure.
4) Remove damaged material from job site. Report and replace damage materials.
5) Plant materials must be watched carefully. Watering the plants can be necessary during a long storage period. Ensure plants are properly ventilated to prevent overheating. Plating materials are to be installed within twenty-four hours from the time that they are received on the project site and may not remain stacked on a pallet for more than 2 hours.
6) When storing materials on the roof be sure that the load of the materials does not exceed the load of the structure. Coordinate with architect and general contractor on structural allowances for placing pallets on the roof and ensure crane is appropriately sized to reach designated areas of the roof.
7) Store materials in dry, protected areas in an upright position. Control temperature of storage areas in accordance with Manufacturer's instructions. Protect moisture sensitive materials with breathable tarps on sides and top surfaces.
8) Store and dispose of solvent based materials and materials used with solvent based materials in accordance with requirements of local authorities having jurisdiction.
9) Bonding adhesives shall be stored at temperatures above forty degrees Fahrenheit and five degrees Celsius.
10) All flammable materials shall be stored in a cool dry area away from sparks, open flames, and gasoline tanks. Follow precautions outlined on containers or supplied by the material manufacturer or supplier.

B) Bulk Materials:
1) Do not dump or store bulk materials on or near structures, utilities, walkways and pavements, or existing roof areas or plants.
2) Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of debris-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
3) Accompany each delivery of bulk materials with product certificates.

IX) PROJECT CONDITIONS

A) Codes/Regulations
1) Follow local, state and federal regulations, safety standards and codes. When a conflict exists use the stricter requirement.

B) Weather Limitations
1) Do not install thermoplastic membranes when moisture in any form (i.e. rain, dew, ice, frost, snow, etc.) is present on the roof deck.
2) Proceed with roofing only when existing and forecasted weather conditions permit.
3) Ambient temperatures shall be above 45° F or 7.2° C when applying water-based adhesives.

4) Wind speeds are not to exceed 40 mph.

C) Planting Constraints:
   1) Zone 3
      (a) For projects throughout Zone 3, install date should be after May 15th and completed no later than September 15th in calendar year.
   2) Zone 4
      (a) For projects throughout Zone 4, install date should be after May 1st and completed no later than September 30th in calendar year.
   3) Zone 5
      (a) For projects throughout Zone 5, install date should be after April 15th and completed no later than October 31st in calendar year.
   4) Zone 6
      (a) For projects throughout Zone 6, install date should be after March 15th and completed no later than November 30th in calendar year.
   5) Zone 7 +
      (a) No constraints as long as temperatures do not go below freezing for 72 consecutive hours.

D) Structural Conditions:
   1) Ensure deck is structurally sound to support the live and dead load requirements of the waterproofing system and sufficiently rigid to support construction traffic.

E) Scheduling Conditions:
   1) Sequencing and Scheduling: The work shall be scheduled in the construction sequence so that designated complete contiguous areas can be installed and completed, including overlay elements and wear courses, before other construction trades are allowed in the area. Prior to starting the Work, all drains shall be operative and all deck projections, sleeves and all other penetrations shall be installed, in place and operative.

X) WARRANTIES

A) The Total System Provider shall furnish its standard [5] [10] [15] [20] warranty for labor and materials, including the membrane, membrane flashings, protection course, drainage medium, insulation and all other vegetated roof components supplied by the manufacturer.

B) Warranty for Plant Growth: Installer agrees to submit growers' product guarantee. Installer and owner agree to adhere to Greenformation® maintenance plan regarding repair or replace plantings within a specified establishment warranty period after installation of vegetation. Establishment warranty shall be defined as: 2 months after vegetation installation, or otherwise known as substantial completion.
   1) Start Date: If chosen, the start date of the warranty for plant growth shall be the substantial date of completion of vegetated assembly and after Greenformation® plan has been approved by owner.
   2) Coverage: Labor and Plantings
   3) Failures include, but are not limited to, death and unsatisfactory growth except for defects resulting from abuse or incidents that are beyond contractor's control including, but not limited to, damage caused by other trades or foot traffic caused by others.
      (a) Visual failure will be determined as a perennial, shrub, or tree that has more than 25 percent of dead plant growth.
   4) Minimum Foliage Cover: Planted materials shall grow to achieve and maintain at least:
      (a) 50 percent foliage cover over planting area commencing 12 months after planting, through the duration of this warranty.
      (b) 80 percent foliage cover over planting area commencing 24 months after planting, through the duration of this warranty.
   5) Include the following remedial actions as a minimum:
      (a) Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
      (b) Installation time of replacement planting(s) to be completed by installer, at their discretion in relation to weather, by no longer than 12 months from removal of dead vegetation.
      (c) If the death of 25 percent or greater of plant materials installed occurs at a single time that is not related to an act of God or owner negligence, Hanging Gardens is to provide owner and installer a remediation plan to remedy the situation.

(d) Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
(i) A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.

XI) BIDDING REQUIREMENTS

A) Pre-Bid Meeting: A pre-bid meeting shall be held with the Owner's Representative and involved trades to discuss all aspects of the project. The Applicator's field representative or roofing foreman for the work shall be in attendance. Procedures to avoid rooftop damage by other trades shall be determined.
B) Site Visit: Bidders shall visit the site and carefully examine the areas in question as to conditions that may affect proper execution of the work. All dimensions and quantities shall be determined or verified by the contractor. No claims for extra costs will be allowed because of lack of full knowledge of the existing conditions unless agreed to in advance with the Owner or Owner's Representative.

XII) MAINTENANCE SERVICE

A) Initial Maintenance Service: Provide maintenance by skilled employees of vegetated roof assembly Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but not for less than the following maintenance period:
1) Initial maintenance period: [30][60][90] days from date of Planting Completion.
B) Continuing Maintenance Proposal: From vegetated roof assembly Installer to Owner, provide Greenformation® a minimum of a 24-month maintenance plan, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
1) Maintenance Period: 24 months from date of Planting Completion.

PART 2 PRODUCTS

I) VEGETATED ROOFING SYSTEM

A) Basis of Design: Hanging Gardens, LLC, http://www.hanging-gardens.com
B) All products and services shall be approved/procured through the Vegetated Roof Provider, Hanging Gardens, in order to ensure integrity of the total system and maintain the total system warranty.

II) WATERPROOFING MEMBRANE AND ACCESSORIES

A) Waterproof Membrane – Basis of Design – Sika Sarnafil
1) Sarnafil G476-15, 60 mil (1.5 mm), thermoplastic flashing membrane with fiberglass reinforcement.
2) Sarnafil G476-20, 80 mil (2.0 mm), thermoplastic flashing membrane with fiberglass reinforcement.

Parameters	ASTM Method	Typical Physical Properties
Membrane thickness, inches (mm)	D 638	0.060 (1.5)
Tensile Strength, psi.	D 751	1631
Elongation at Break, %	D 751	279 MD, 267 CMD
Seam Strength, % of Tensile Strength	D 751	86%
Retention of Properties After Heat Aging	D 3045	
Tensile Strength, % of original	D 751	90%
Elongation at Break, % of original	D 751	90%
Tear Resistance, lbf	D 1004	21.0
Linear Dimensional Change, %	D 1204	0.0
Weight Change after immersion in water, %	D570	1.5
Static Puncture Resistance, 33 lbs.	D5602	Pass

Dynamic Puncture Resistance, 10 J	D5635	Pass

B) Flashing
   1) Non-exposed flashings
      (a) Sarnafil G476-15, 60 mil (1.5 mm), thermoplastic flashing membrane with fiberglass reinforcement.
      (b) Sarnafil G476-20, 80 mil (2.0 mm), thermoplastic flashing membrane with fiberglass reinforcement.
   2) Exposed flashings
      (a) Sarnafil G410-15, 60 mil (1.5 mm), thermoplastic flashing membrane with fiberglass reinforcement.
      (b) Sarnafil G410-20, 80 mil (2.0 mm), thermoplastic flashing membrane with fiberglass reinforcement.
      (c) Sarnafil G459-15, 60 mil (1.5 mm), thermoplastic, asphalt resistant, grid strip and flashing membrane with fiberglass reinforcement.

C) Adhesives
   1) Sarnacol 2170
      (a) A solvent-based reactivating-type adhesive used to attach membrane to the flashing substrate in areas where self-adhered membrane is not used.
   2) Sarnacol 2121
      (a) A water-based adhesive used to attach the membrane to the flashing substrate in areas where self-adhered membrane is not used.
   3) Sikaflex-11FC
      (a) Membrane adhesive for certain flashing details.

D) Attachment Components
   1) Sarnafastener-CD10
      (a) A nail-in, corrosion-resistant fastener used with Sarnabar-SS to attach Sarnafil membrane to structural concrete roof decks.
   2) Sarnafastener #14
      (a) A #14 corrosion-resistant fastener used with Sarnabar-SS to attach Sarnafil membrane to structural concrete or wood roof decks.
   3) Sarnafastener-XP
      (a) A #15, heavy-duty, corrosion-resistant fastener used with Sarnabar-SS to attach Sarnafil membrane to steel roof decks.
   4) Sarnabar-SS
      (a) Heavy-duty, 14 gauge, roll-formed stainless steel bar used to attach membrane to decks.
   5) Sarnastop
      (a) An extruded aluminum, flat low profile bar used to terminate flashing membrane.
   6) Masonry Anchor
      (a) A drive-pin expansion type fastener with zinc sheaths and stainless steel pins for attachment of Sarnabar and Sarnastop to concrete, masonry, and brick.

E) Accessories
   1) Sarnaclad-SS
      (a) A PVC-coated, heat weldable sheet metal capable of being formed into a variety of shapes and profiles. Sarnaclad-SS is a stainless steel sheet metal with an unsupported Sarnafil membrane laminated on one side for buried or concealed flashing conditions.
   2) Sarnaclad
      (a) A PVC-coated, heat-weldable sheet metal capable of being formed into a variety of shapes and profiles. Sarnaclad is a 25 gauge, G90 galvanized metal sheet with a 20 mil (0.5 mm) unsupported Sarnafil membrane laminated on one side for above grade flashing locations.
   3) Aluminum Tape
      (a) A pressure-sensitive aluminum tape used as a separation layer between small areas of asphalt contamination and as a bond-breaker under the cover strip at Sarnaclad-SS joints.
   4) Sarnamatic
      (a) 220 volt, self-propelled, hot-air welding machine used to seal long lengths of Sarnafil membrane seams.

5) Sarnacorner-Inside/Outside
   (a) Prefabricated inside and outside flashing corners made of PVC membrane that are heat-welded to membrane or Sarnaclad base flashings.
6) Sikaflex Primer 449
   (a) A solvent-based primer used to prime the back of G459 grid strip membrane to improve adhesion to Sikalfex-11FC.
7) Sikaflex®-1a
   (a) Sealant used at flashing terminations and pitch pocket filler.
8) Multi-Purpose Tape
   (a) A high-performance sealant tape used with metal flashings as a preventive measure against air and windblown moisture entry.
9) Sarnacircle
   (a) Circular 48 mil (1.2 mm) G410 membrane patch welded over T-joints formed by overlapping membranes greater than 60 mil (1.5 mm) in thickness.
10) Sarnacord-PVC
   (a) A 5/32 inch (4 mm) diameter, red-colored, flexible thermoplastic extrusion that is welded to the top surface of the Sarnafil membrane against the outside edge of Sarnabar-SS, used to hold the membrane in position.

III) VAPOR BARRIER

A) Sarnavap-10
   1) A 10 mil (0.25 mm) thick polyethylene vapor retarder/air retarder.
B) Sarnavap Self-Adhered
   1) A 32 mil (0.8 mm) self-adhesive vapor barrier that can also serve as temporary roof protection.

IV) INSULATION / THERMAL BARRIER / COVER BOARD

A) Board Insulation: 10, 25, 40 and/or 60 psi Expanded Polystyrene Geofoam complying with IBC requirements for foam and plastic insulation.
   1) Tapered Edge Strip: Factory fabricated rigid perlite strip cut at angles to provide a smooth transition between differences in elevation.
B) DensDeck® Thermal Barrier
   1) A siliconized gypsum, fire-tested roof board with glass-mat facer used as a thermal barrier underlayment in certain roof constructions. Thicknesses as noted on Project Drawings.
C) DensDeck® Cover Board
   1) A 1/4 inch (6 mm) thick fire-tested, gypsum cover board with glass-mat facers.

V) ELECTRONIC LEAK DETECTION (ELD) MATERIALS

A) Stainless Steel Grid Method
   1) Conductor Cable: Nine strands of 0.06-inch (1.5 mm) diameter highly-conductive stainless-steel wire interwoven with braided polyethylene strands, placed on weather side of membrane:
   2) Measurement Grid: Highly conductive, corrosion resistant, geometrically stable mesh placed between membrane and protected building components.
   3) Stainless steel grid: 1 by 1-inch (25 by 25 mm) screen mesh in 48 inch by 160 foot (1.2 by 50 m) rolls.
   4) Conductor Wire Assembly: Provide grounding plate for connection to measurement grid, suitable for connection to terminals at contact box.
   5) Contact Box: Weatherproof, corrosion-resistant electrical enclosure with permanent terminal connections for connecting diagnostic and testing equipment, NEMA **[**4X**]** with the following characteristics:
      (a) Permanent connections for attachment of diagnostic and testing equipment without opening contact box.
      (b) Weatherproof cover to seal terminals when leak detection system is not in use.
      (c) Hardware, brackets, and fittings required to permanently mount contact box to building structure.
   6) Accessories:

(a) Provide corrosion-resistant fasteners and hardware, electrical terminations, sealants, and other items required to provide complete installation.
(b) Lap Joint Tape: Provide self-adhesive aluminum tape, minimum 2 inch (50 mm) wide.

B) Conductive Primer Method
1) Conductive Primer
(a) Material Properties:
(i) Odor: Odorless
(ii) Solids by Volume: 23.2%
(iii) Solids by Weight: 13%
(iv) Weight per Gallon: 8.2 lb.
(v) VOC: Less than 100 grams/liter (0.000 lb/gal)
(vi) Tints (pigments) carbon black
(vii) Primary Material: water-based epoxy resin

VI) RELATED ROOFING MATERIALS

A) Wood Nailer
1) Wood nailers shall be treated for fire and rot resistance (ACQ treated) and be #2 quality or better lumber. Creosote or asphalt-treated wood is not acceptable. Wood nailers shall conform to Factory Mutual Loss Prevention Data Sheet 1-49. All wood shall have a maximum moisture content of 19% by weight on a dry-weight basis.

B) Plywood
1) When adhering the flashing membrane directly to plywood, a minimum 1/2 inch (13 mm) CDX (C side out), smooth-surfaced exterior grade plywood with exterior grade glue shall be used. Rough-surfaced plywood or high fastener heads will require the use of Sarnafelt behind the flashing membrane. Plywood shall have a maximum moisture content of 19% by weight on a dry weight basis.

C) Miscellaneous Fasteners and Anchors
1) Fasteners are to be compatible with materials in contact with fasteners. All fasteners and anchors shall have a minimum embedment of 1-1/4 inches (31.7 mm) and shall be approved for such use by the fastener manufacturer. Fasteners for attachment of metal to wood blocking shall be annular ring nails. Fasteners for attachment of metal to masonry shall be all-metal expansion type fasteners. All fasteners shall meet Factory Mutual Standard 4470 for corrosion resistance.

VII) PROTECTION LAYER – PAVED SYSTEMS

A) Protective Fleece: To protect membrane from paver pedestals and vegetated roof assembly.
1) Type: Semi-Intensive Protective Fleece [HG 3320]
(a) Properties: 15 oz Polypropylene, Polyester and Recycled Acrylic Thread
(b) Water Holding Capacity: 20.16 in^3/ft^2
(c) Total Saturated Weight: 0.82 lbs/ft^2

VIII) DRAINAGE LAYER – POURED IN PLACE CONCRETE

A) Paving Drain
1) Type: Pedestrian Paving Drain [HG 3530]
(a) Properties: 0.40” composite drainage layer consisting of a three-dimensional drainage core and filter fabric bonded to the core.
(b) Application: For projects that require less than 11,000 psf of compressive strength.
2) Type: Vehicular Paving Drain [HG 3540]
(a) Properties: 0.40” composite drainage layer consisting of a three-dimensional drainage core and filter fabric bonded to the core.
(b) Application: For projects that require between 11,000 – 33,000 psf of compressive strength

IX) VEGETATED ROOFING MATERIALS

A) Protective Fleece: To protect membrane from paver pedestals and vegetated roof assembly
1) Type: Semi-Intensive Protective Fleece [HG 3320]
(a) Properties: 15 oz Polypropylene, Polyester and Recycled Acrylic Thread

(b) Water Holding Capacity: 20.16 in^3/ft^2
(c) Total Saturated Weight: 0.82 lbs/ft^2

B) Drainage / Retention Board: To provide stormwater retention while simultaneously allowing for continuous drainage.
1) Type: 1.6” Semi-Intensive DR Board [HG 3616]
(a) Properties: High-density polyethylene, double sided form of interlocking cups with depth 1.6". Perforated holes on top surface for continuous aeration. High load bearing capacity, excellent water retention, passive distribution and drainage properties.
(b) Water Holding Capacity: 48.96 in^3/ft^2
(c) Compressive Strength: 20.88 lbs/in^2 (unfilled), 40.61 lbs/in^2 (filled)

C) Filter Fleece: Filter separation layer between drainage and substrate layers.
1) Type: Semi-Intensive Filter Fleece [HG 3720]
(a) Properties: 6 oz system filter, rot and pathogen resistant, non-woven, polymeric, geotextile fabric.
(b) Tensile Strength: 2.54 lbs/in^2
(c) Total Saturated Weight: 0.06 lbs/ft^2

D) Edge Restraints: Self-supporting vertical separation between paver and growing media and contain exposed vegetated roof edge.
1) Type: Semi-Intensive Aluminum Edge [HG 3930]
(a) Properties: L-shaped self-supporting 12 GA Aluminum with perforations along the manifold for continuous drainage. Male & female pieces allow for ease in installation and minimize cutting. Inside and outside corners also manufactured to create seamless corners.
(b) Size: 9” height x 6” flange x 8’ sections. Can be ordered in customized dimensions if variation in finish elevation.
2) Type: Intensive Aluminum Edge [HG 3940]
(a) Properties: L-shaped self-supporting 12 GA Aluminum with perforations along the manifold for continuous drainage. Male & female pieces allow for ease in installation and minimize cutting. Inside and outside corners also manufactured to create seamless corners.
(b) Size: 12” height x 6” flange x 8’ sections. Can be ordered in customized dimensions if variation in finish elevation.
3) Custom Edge [HG 3990]
(a) For any custom edges or corners request inquiry from Total System Provider.

E) High Wind Stabilization Grid
1) A geogrid reinforcement constructed of high molecular weight and high tenacity polyester yarns utilizing a complex knitting process and polymeric coating to provide superior engineering properties.
2) Tensile strength of netting 55 kN/m
3) ASTM Standards:
(a) D5262: Standard test method for evaluating the unconfined tension creep and creep rupture behavior of geosynthetics.
(b) D6637: Standard test method for determining tensile properties of geogrids by the single or multi-rib tensile method.

F) Drain/Access Box: Control shaft for use as roof outlet inspection units.
1) Type: Drain/Access Box [HG 3550]
(a) Properties: UV Resistant ABS Plastic with inlet slots in shaft walls and cover.
(b) Size: 14.5” x 14.5” x 4”
(c) Components: Includes a lockable lid and stainless-steel filter to prevent debris from entering the drainage system.
(d) System comes in increments of 4” to achieve desired height.
(e) Metal Access Box Cover available upon request from Total System Provider.

G) Growth Media: Vegetated roof assembly supplier’s lightweight, custom manufactured soil mixture designed for project location and plant pallet.
1) Type: Semi-Intensive Growth Media [HG 4210]

(a) Properties: Formulated growth media to meet European FLL Guidelines for particle size gradation, dry vs saturated bulk density, porosity, water retention hydraulic conductivity, pH balance and organic matter content.
(b) Plantings: Expanded plant palettes

H) Perennial Plugs
1) Type: Perennial Plugs [HG 6200]
(a) Perennial Plugs shall be healthy vigorous plants and may include the following container sizes that will provide rapid root development:
(i) 72 cell
(ii) 32 cell
(iii) Quart pot
(iv) Gallon pot
(b) Perennial Plugs shall be delivered in the following means to ensure plants are healthy at receipt of materials:
(i) For air shipment, an insulated box with enclosed ice packs to ensure the perennial plugs remain cool and temperate until they are delivered.
(ii) For local shipment, all trucks need to be vented and/or plants must be in protected conditions that moderates temperatures from 40°F-85°F during shipment. Shipments of greater than four hours shall require air shipping standards.
(c) Contact Total System Provider for available and/or In-Season varieties. Reference Hanging Gardens Technical Guide and/or website for commonly available plantings.

I) Specified Plantings
1) Nursery stock plantings grown in accordance to the standards of American Nursery and Landscape Association.

J) Paver Pedestals
1) Type: SpiralJack Pedestals [HG 5100]
(a) Properties: Recycled Polypropylene resistant to mold, alkali and bitumen.
(b) Base Diameter: 6 1/16” standard, 6 3/4” with Base Slope Corrector.
(c) Height Range: ½” - 4 ¾”
(d) Maximum Compressive Strength: 4,496 lbs. (20 kN)
(e) Components: Separate tab and shim components available if roof slope compensation is desired.
(i) Standard Spacer tabs available in 5/64”, 1/8”, 5/32”, 1/4”, and 3/8” widths.
2) Type: DeckJack Pedestals [HG 5200]
(a) Properties: Recycled Polypropylene resistant to mold, alkali and bitumen.
(b) Base Diameter: 7 1/2” standard, 8 7/8” with Base Slope Corrector.
(c) Height Range: 1 ½” – 40 ¼”
(d) Maximum Compressive Strength: 3,372 lbs. (15 kN)
(e) Components: Separate tab and shim components available if roof slope compensation is desired.
(i) Standard Spacer tabs available in 5/64”, 1/8”, 5/32”, 1/4”, and 3/8” widths.

K) Walkway Pavers
1) Type: Classic-Line Concrete Pavers [HG 5310]
(a) Finish: Available in 12 standard colors as well as custom varieties available upon request.
(b) Standard size: 23 3/8” x 23 3/8” x 2” (Actual)
(c) Weight: 24 lbs. / ft^2
(d) Compressive Strength: > 8,000 lbs. / in^2
2) Type: Flex-Line Concrete Pavers [HG 5320]
(a) Finish: Available in 24 standard colors as well as custom varieties available upon request.
(b) Standard size: 23 7/8” x 23 7/8” x 2” (Actual)
(i) Other Available Sizes (Actual):
(i) 1 ¼”- 3” thicknesses
1. 11 ¾” x 11 ¾”
2. 11 ¾” x 23 ½”
(ii) 1 ½” - 3” thicknesses
1. 11 ¾” x 36”

2. 12” x 36”
3. 14 ½” x 14 ½”
4. 14 5/8” x 29 5/8”
5. 15 ¾” x 15 ¾”
6. 15 ¾” x 23 5/8”
7. 17 5/8” x 17 5/8”
8. 18” x 18”
9. 17 5/8” x 23 ½”
10. 23 ½” x 23 ½”
11. 23 ¾” x 23 ¾”
12. 24” x 24”

(iii) 2” - 3” thicknesses
1. 17 5/8” x 35 3/8”
2. 23 ½” x 29 ½”
3. 23 ½” x 35 3/8”
4. 29 ½” x 29 ½”
5. 29 ¾” x 29 ¾”

(iv) 2 ½” - 3” thicknesses
1. 35 ½” x 35 ½”

(c) Weight: 23 lbs. / ft^2
(d) Compressive Strength: > 9,500 lbs. / in^2

L) Type: Wood Deck Tiles [HG 5350]
1) Materials: Ipe, Cumaru, Tigerwood, Black Locust, Garapa, Massaranduba, and/or Itauba.
(a) Sizes (Actual):
(i) 23 5/8” x 23 5/8” x 1 1/2”
(ii) 23 5/8” x 47 3/8” x 1 1/2”
(b) Weight: 6 lbs. / ft^2

M) Type: Porcelain Pavers [HG 5360]
1) Finish: Available in 23 different finishes. Please contact Hanging Gardens, LLC for samples.
2) Sizes (Actual):
(a) Wood Finish
(i) 11 13/16” x 47 1/4” x ¾”
(ii) 23 5/8” x 47 1/4” x ¾”
(b) Stone Finish
(i) 23 5/8” x 23 5/8” x ¾”
(ii) 23 5/8” x 47 1/4” x ¾”
3) Weight: 9 lbs. / ft^2

N) Drainage Stone
1) Material: Smooth landscape stone
2) Size: 1/2"-1” diameter
3) Shape: Round / elliptical. Any stone with sharp edges will be rejected.

PART 3 EXECUTION

I) EXAMINATION

A) Verify that the surfaces and site conditions are ready to receive work.
B) Verify that the deck is supported and secured
C) Verify that the deck is clean and smooth, free of depressions, waves, or projections, and properly sloped to drains, valleys, eaves, scuppers or gutters.
D) Verify that the deck surfaces are dry and free of ice or snow.
E) Verify that all roof openings or penetrations through the roof are solidly set, and that all flashings are tapered.
F) Applicator shall be responsible for acceptance or provision of proper substrate to receive new waterproofing materials.
G) Applicator shall verify that the work done under related sections meets the following conditions:
1) Roof drains and/or scuppers have been reconditioned and/or replaced and installed properly.
2) Roof curbs, nailers, equipment supports, vents and other roof penetrations are properly secured and prepared to receive new waterproofing materials.

3) All surfaces are smooth and free of dirt, debris and incompatible materials.

II) PREPARATION

A) Remove trash, debris, grease, oil, water, moisture and other contaminates from the deck, which may affect bond of bitumen and/or thermoplastic materials to deck surface.
   1) NOTE: Sandblasting and/or shot-blasting procedures may be required on certain renovation work to provide the best possible surface. If required, provide unit price per square foot in bid documents.

B) Substrate Preparation: Verify that substrate complies with roofing manufacturers and leak detection manufacturer's requirements. Proceed with installation once substrate complies with the following requirements:
   1) Metal Deck
      (a) Metal decks shall be a minimum uncoated thickness of 24 gauge (0.8 mm) and shall have a G-90 galvanized finish on all panels.
      (b) Decks shall comply with the gauge and span requirements in the current Factory Mutual FM Approval Guide and be installed in accordance with Loss Prevention Data Sheet 1-28 or specific FM approval.
      (c) When re-roofing over metal decks, surface corrosion shall be removed, and repairs to severely corroded areas made. Loose or inadequately secured decking shall be fastened, and irreparable or otherwise defective decking shall be replaced.
   2) Structural Concrete Deck:
      (a) Minimum deck thickness for structural concrete is 4 inches (102 mm).
      (b) Only poured in place concrete decks that provide bottom side drying are acceptable.
      (c) The roof deck shall be properly cured prior to application of the roofing system. Curing agents shall be checked for compatibility with roofing materials. Prior to the installation of the roof assemblies, evaluation of the surface moisture and deck's dryness by the use of ASTM D 4263 or hot bitumen test procedures shall be conducted.
      (d) The deck shall be smooth, level and cannot be wet or frozen.
      (e) Treat cracks greater than 1/8 inch (3 mm) in width in accordance with the deck manufacturer's recommendations.
      (f) Sumps for the roof drains shall be provided in the casting of the deck.
      (g) With retrofit roof applications, it is required that the deck be inspected for defects. Defects are to be corrected per the deck manufacturer's recommendations prior to the roofing application.
   3) Lightweight Insulating Concrete:
      (a) Lightweight insulating concrete decks are required to have a minimum thickness of 2 inches (51 mm), a minimum compressive strength of 125 psi (0.86 MPa) and a minimum density of 22 pcf (352 kg/sm).
      (b) The lightweight insulating deck/fill shall be installed by an applicator approved by the deck manufacturer.
      (c) The roof system shall be installed immediately following deck curing to prevent damage from exposure to precipitation. The deck manufacturer determines the minimum curing time and maximum exposure limitations.
      (d) LWIC shall not be poured during rainy periods. Deck areas that have frozen before they have cured shall be removed and replaced. Decks which receive precipitation prior to installation of the roof membrane shall be checked for moisture content and dryness.
      (e) The moisture content of existing LWIC shall be under 20 percent when insulation is to be fastened directly to it. Where moisture content exceeds 20 percent, a layer of approved Venting Base Sheet shall be installed prior to the insulation.
      (f) Lightweight insulating concrete decks are acceptable only on slopes up to 1 inch per foot (83 mm/m).

III) GENERAL INSTALLATION

A) Install roof system in accordance with manufacturer's instructions.

IV) WOOD NAILER INSTALLATION

A) Install continuous wood nailers at the perimeter of the entire area and around projections and penetrations as shown on the Project Drawings. Thickness shall be as required to match substrate and/or insulation height to allow a smooth transition.
B) Nailers shall be anchored to resist a minimum force of 300 pounds per lineal foot (4,500 Newtons/lineal meter) in any direction. Individual nailer lengths shall not be less than 3 feet (0.9 meter) long. Nailer fastener spacing shall be at 12 inches (0.3 m) on center or 16 inches (0.4 m) on center if necessary to match the structural framing. Fasteners shall be staggered 1/3 the nailer width and installed within 6 inches (0.15 m) of each end. Two fasteners shall be installed at ends of nailer lengths. Nailer attachment shall also meet the requirements of the current Factory Mutual Loss Prevention Data Sheet 1-49.
C) Stainless steel, corrosion resistant, fasteners are required when mechanically attaching any Sika Sarnafil product to wood nailers and wood products treated with ACQ (Alkaline copper Quaternary). When ACQ treated wood is used on steel roof decks or with metal edge detailing, a separation layer must be placed between the metal and ACQ treated wood.

V) VAPOR BARRIER INSTALLATION

A) General:
    1) Air/vapor barrier sheet shall typically be installed when required by design professional to address internal air pressure or humidity conditions.
    2) Insulation must be installed over the air/vapor barrier sheet and mechanically attached to the deck.
B) Application:
    1) Install air/vapor barrier sheet loose-applied to the deck or fire board so that wrinkles and buckles are not formed.
C) Overlap air/vapor barrier sheets a minimum of 6" for side and end laps. Tape laps together with duct tape or double-sided tape.
D) Seal perimeter and penetration areas with compatible foam sealant.

VI) INSULATION INSTALLATION

A) Insulation shall be set in cold adhesive. Follow cold adhesive manufacturer's installation instructions.
B) Insulation board size as recommended by manufacturer for adhered application.
C) Subsequent layers of insulation shall be adhered with cold adhesives. Follow cold adhesive manufacturer's installation instructions.
D) Do not install wet, damaged or warped insulation boards.
E) Install insulation boards with staggered board joints in one direction.
F) Insulation boards to be installed so that no gaps larger than 1/4 inch (6 mm) are found at the end joints and that the adjoining top surfaces are flat and smooth. All gaps more than 1/4 inch (6 mm) shall be filled with like insulation material.
G) If more than one layer of insulation board is to be installed the joints of the subsequent layers must be staggered. Stagger the joints in the additional layers a minimum of 6 inches (152 mm) from the underlying insulation boards to eliminate vertical gaps.
H) Do not install any more insulation than will be completely waterproofed each day.
I) Provide separation layer as required by manufacturer.

VII) COVER BOARD INSTALLATION

A) Cover boards shall be set in cold adhesives over the insulation board. Follow cold adhesive manufacturer's installation instructions.
B) Cover boards to be installed so that no gaps larger than 1/4 inch (6 mm) are found at the end joints and that the adjoining top surfaces are flat and smooth.
C) Stagger the joints in the cover board a minimum of 6 inches (152 mm) from the underlying insulation boards to eliminate vertical gaps.
D) Do not install any more cover board than will be completely waterproofed each day.

X) ELECTRONIC LEAK DETECTION (ELD) SYSTEM INSTALLATION

A) Stainless Steel Grid Method

1) Examination: Verify that substrate complies with roofing manufacturer's and leak detection manufacturer's requirements. Proceed with installation once substrate complies with requirements.
2) Measurement Grid: Install measurement grid on membrane substrate immediately under membrane and immediately prior to installation of membrane.
   (a) Verify that location of measurement grid fasteners does not interfere with or cause damage to membrane.
   (b) Fasten measurement grid in accordance with leak detection system manufacturer's requirements.
   (c) Do not place measurement grid where it will be in continuous direct contact with concrete.
   (d) Provide minimum 2 inch (50 mm) overlap where adjacent sheets meet, including side laps and end laps.
   (e) Apply minimum 6-inch (150 mm) strips of aluminum tape on 5-foot (1.5 m) center spacing where adjacent sections of measurement grid overlap.
   (f) Ground Plate and Conductor Wire: Install ground plate under measurement grid in accordance with manufacturer's published recommendations. Extend conductor wire through membrane to contact box and connect to terminations.
   (g) Verify that location of measurement grid fasteners does not interfere with, or cause damage to membrane.
   (h) Fasten measurement grid in accordance with measurement grid manufacturer's published recommendations.
3) Conductor Wire: Install conductor wire on top of membrane at spacing and layout indicated on approved shop drawings.
   (a) Secure conductor wire using method recommended by manufacturer.
4) Installation Testing: Verify continuity and functioning of conductor wire and measurement grid upon completion of installation.

B) Conductive Primer Method
1) Examination:
   (a) Do not begin primer installation until substrates have been properly prepared.
   (b) Surface should be clean and dry. Do not apply to wet or moisture-soaked materials. Heavy dirt, grease, or other contaminates need to be removed using proper cleaning methods.
   (c) During hot temperatures surfaces can be extremely hot. Special attention is needed. Apply product in small areas to test application.
   (d) For previously coated surfaces, certain plastics (e.g. PVC) or glossy surface finishes contact manufacturer or manufacturer’s representative for guidance.
2) Primer Application:
   (a) Application using a roller- Mix pails of Conductive Primer thoroughly so that the primer has uniform viscosity, color and transparency. Turning the pails upside-down before opening for five minutes is recommended to ensure proper mixing. After mixing, apply the primer using a roller in an even coat so that the substrate turns entirely black. Any coloration of the substrate visible through the primer indicates a shortage of primer and must have more primer applied. Porous substrates such as plywood may require two coats of primer to ensure proper coverage.
   (b) Spray Application - Mix pails of Conductive Primer thoroughly so that the primer has uniform viscosity, color and transparency. Turning the pails upside-down before opening for five minutes is recommended to ensure proper mixing. After mixing apply the primer using a spray gun so that the substrate turns entirely black. Apply with a steady pattern with 3-inch (76 mm) overlaps. Any coloration of the substrate visible through the primer indicates a shortage of primer and must have more primer applied. Porous substrates such as plywood may require two coats of primer to ensure proper coverage.
   (c) Minimum thickness:
      (i) 0.8 to 1.0 mils thick dry film
   (d) Minimum coverage:
      (i) Minimum coverage of 300 to 400 sq. ft per gallon (28 sq. m/l to 37 sq. m/l) required
3) Continuity Bonding

(a) If the primer is to be applied to substrate on the jobsite then continuity will be established without the use of foil tape. If the joints of the individual sheets of coverboard have a gap larger than 1/8" then the primer must be applied in the joints using a paint brush to ensure that each individual coverboard sheet has continuity with the surrounding sheets.
(b) If the primer is to be applied on the coverboard sheets prior to installation on the jobsite then continuity bonding is required. Continuity bonding can be established using 6" pieces of aluminum foil tape installed perpendicularly across each joint of coverboard. After the aluminum foil tape is installed then primer must be applied on top the tape.

4) Establishing Connection Points
(a) To perform the electronic leak detection test after the membrane is installed, the primer must have at least two connection points with metallic penetrations such as drains, HVAC units and vents. To establish a connection point, apply the primer to the side of a metallic penetration while applying the primer to the main portions of the substrate. Note all metal penetrations that were coated with primer. By establishing at least two connection points on opposite ends of each area a continuity test can be performed by the leak detection technician to ensure the validity of the electronic leak detection test.
(b) If no metallic penetrations are located within an area where primer is being installed, then a grounding object must be installed. Any metallic object can be fastened to the structural deck and connected to the primer by coating the side of object with primer. Flash grounding object with roofing membrane same per requirements of the manufacturer.

VIII) MEMBRANE INSTALLATION

A) Comply with Manufacturer's most current installation instructions, specific recommendations, and approved shop drawings for this project.
B) Workmen and all others that walk on waterproofing shall wear clean, soft-soled shoes so as not to damage materials. Heed all manufacturer's cautions and warnings in regard to product use. Membrane is slippery when wet or covered with frost, snow and ice. Take proper precautions. Lay out work to minimize traffic over installed areas.
C) Unroll and position the waterproofing membrane over the substrate. Be sure to remove all shipping tape from the membrane.

IX) HOT-AIR WELDING OF LAP AREAS

A) General
1) All surfaces to be welded shall be clean and dry. No contaminants shall be present within lap areas.
2) Welding equipment shall be provided by or approved by Manufacturer. All mechanics intending to use the equipment shall be trained and qualified and shall have successfully completed a course of instruction provided by Manufacturer's representative prior to welding.
3) Adjacent sheets shall be welded in accordance with Manufacturer's instructions. All side and end lap joints shall be hot air welded. Lap area shall be a minimum of 3 inch (76.2 mm) wide when machine welding, and a minimum of 4 inch (10.2 cm) wide when hand welding. Overlaps shall be with the flow of water where possible.
4) Install Manufacturer approved turnbar and fasten 12 inches (30 cm) on center with acceptable fasteners into the structural deck, at the base of parapets, walls, and curbs according to Manufacturer's recommended details. Hot-air weld PVC cord to the waterproofing membrane on the penetration side of the approved turnbar. Weld a 4 in. (10.2 cm) wide membrane protection strip over bar ends and intersections.

B) Machine Welding
1) Machine welded seams are achieved by the use of automatic welding equipment. When using this equipment, Manufacturer's instructions must be followed and local codes for electric supply, grounding and over current protection observed. Dedicated circuit house power or a dedicated portable generator (30 A, 220 V, and recommended min. 7,500 Watts) is required. No other equipment shall be operated off the generator.

C) T-Joints (three-way overlaps)
1) The second layer (middle layer) of membrane of all T-Joints formed with membrane greater than 60-mils in thickness must be shaved down to create a smooth transition for the top layer of membrane prior to hot-air welding. A 4 inch (10.2 cm) round or square (with rounded

corners) patch of max. Manufacturer approved 60 mil thick membrane must be hot-air welded over the center of the T-Joint intersection. The edges of the membrane forming the T-Joint must be shaved to provide a smooth transition for the patch.

D) Quality Control of Welded Seams
   1) All completed welded seams shall be checked by the waterproofing Applicator after cooling for continuity using a rounded screwdriver or other suitable blunt object. On-site evaluation of welded seams shall be made daily by the Applicator. Cross-section samples shall be taken a minimum of two times a day (AM/PM) through completed seams and evaluated immediately. The samples must be dated and saved for evaluation by a Manufacturer's Technical Representative. Each test cut shall be patched by the Applicator.

X) EXPANSION JOINTS INSTALLATION

A) The membrane shall be mechanically fastened (or fully adhered based on system) along edge of expansion joint opening with appropriate fasteners and plates within ¼" to ½" of the membrane edge 12" O.C.

XI) FLASHING INSTALLATION

A) All penetrations shall be at least 2 feet (610 mm) from the curbs, walls, and edges to provide adequate space for proper flashing.
B) Flash all perimeter, curb, and penetration conditions with coated metal, membrane flashing, and flashing accessories as appropriate to the site condition.
C) All coated metal and membrane flashing corners shall be reinforced with preformed corners or non-reinforced membrane.
D) Hot-air weld all flashing membranes, accessories, and coated metal. A minimum 2" wide hand weld or minimum 1 - 1/2" automatic machine weld is required.
E) Non-coated metal edge details shall be installed in accordance with construction details and requirements.
F) Twenty (20) year warranties or greater require the use of coated metal edges where applicable. Bonding adhesive and/or cover tape is not acceptable.
G) Coated Metal Flashings:
   1) Coated metal flashings shall be formed in accordance with construction details and SMACNA guidelines.
   2) Coated metal sections used for roof edging, base flashing and coping shall be butted together with a 1/4-inch (6 mm) gap to allow for expansion and contraction. Hot-air weld a 6 inch (152 mm) wide reinforced membrane flashing strip to both sides of the joint, with approximately 1 inch (25 mm) on either side of the joint left un-welded to allow for expansion and contraction. 2 inch (51 mm) wide aluminum tape can be installed over the joint as a bond-breaker, to prevent welding in this area.
   3) Coated metal used for sealant pans, scupper inserts, corners of roof edging, base flashing and coping shall be overlapped or provided with separate metal pieces to create a continuous flange condition, and pop-riveted securely. Hot-air weld a 6" wide reinforced membrane flashing strip over all seams that will not be sealed during subsequent flashing installation.
   4) Provide a 1/2-inch (12 mm) hem for all exposed metal edges to provide corrosion protection and edge reinforcement for improved durability.
   5) Provide a 1/2-inch (12 mm) hem for all metal flange edges whenever possible to prevent wearing of the roofing and flashing membranes at the flange edge.
   6) Coated metal flashings shall be nailed to treated wood nailers or otherwise mechanically attached to the roof deck, wall or curb substrates, in accordance with construction detail requirements.
H) Roof Edges:
   1) Roof edge flashings are applicable for gravel stop and drip edge conditions as well as for exterior edges of parapet walls.
   2) Flash roof edges with metal flanges nailed 4 inches (102 mm) O.C. to pressure-treated wood nailers. Where required, hot-air weld roof membrane to coated metal flanges.
   3) When the fascia width exceeds 4 inches (102 mm), coated metal roof edging must be attached with a continuous cleat to secure the lower fascia edge. The cleat must be secured to the building no less than 12 inches (305 mm) O.C.

4) Alternatively, roof edges may be flashed with a 2-piece snap on fascia system, adhering the roof membrane to a metal cant and face nailing the membrane 8" on center prior to installing a snap-on fascia.
5) Flash roof edge scuppers with a coated metal insert that is mechanically attached to the roof edge and integrated as a part of the metal edging.

I) Parapet and Building Walls
1) Flash walls with PVC membrane adhered to the substrate with bonding adhesive, loose applied (Less than 18 inches (457 mm) in height) or with coated metal flashing nailed 4 inches (102 mm) on center to pressure-treated wood nailers.
2) When adhering to vertical surfaces greater than 30 inches (76.2 cm) in height, provide intermediate fastening of the flashing membrane according to Manufacturer's requirements.
3) Secure membrane flashing at the top edge with a termination bar. Water Block shall be applied between the wall surface and membrane flashing underneath all exposed termination bars. Exposed termination bars shall be mechanically fastened 8 inches (203 mm) on center; termination bars that are counter flashed shall be fastened 12 inches (305 mm) on center.
4) Roof membrane must be mechanically attached along the base of walls with screws and plates (deck securement) or screws and inverted termination bar (wall securement) at the following rate:
   (a) Mechanically Attached Systems: Per in-lap on center spacing, with a 12-inch (305 mm) maximum
   (b) Fully / Self Adhered Systems: 12 inches (305 mm) on center
   (c) Ballast Applied Systems: 8 inches (203 mm) on center
5) All coated metal wall flashings and loose applied membrane flashings must be provided with separate metal counterflashing's, or metal copings.
6) Metal counterflashing's may be optional with fully adhered flashings depending on guarantee requirements. Exposed termination bars must be sealed with approved caulking.
7) Flash wall scuppers with a coated metal insert that is mechanically attached to the wall and integrated as part of the wall flashing.

J) Curbs and Ducts:
1) Flash curbs and ducts with PVC membrane adhered to the curb substrate with bonding adhesive, loose applied (Less than 18 inches (457 mm) in height) or with coated metal flashing nailed 4 inches (102 mm) on center to pressure-treated wood nailers.
2) Secure membrane flashing at the top edge with a termination bar. Water Block shall be applied between the curb/duct surface and membrane flashing underneath all termination bars. Exposed termination bars shall be mechanically fastened every 8 inches (2.3 mm) o.c.; termination bars that are counter flashed shall be fastened 12 inches (305 mm) on center.
3) Roof membrane must be mechanically attached along the base of walls with screws and plates (deck securement) or screws and inverted termination bar (wall securement) at the following rate:
   (a) Mechanically Attached Systems: Per in-lap on center spacing, with 12 inches (305 mm) maximum
   (b) Fully / Self Adhered Systems: 12 inches (305 mm) on center
   (c) Ballast Applied Systems: 8 inches (203 mm) on center
4) All coated metal curb flashings and loose applied membrane flashings must be provided with separate metal counterflashing's, or metal copings.
5) Metal counterflashing's may be optional with fully adhered flashings depending on guarantee requirements. Exposed termination bars must be sealed with Flex caulking.

K) Roof Drains
1) Roof drains shall be fitted with compression type clamping rings and strainer baskets. Original-type cast iron and aluminum drains, as well as retrofit-type cast iron, aluminum or molded plastic drains are acceptable.
2) Roof drains shall be provided with a minimum 36 inches (914 mm) by 36 inches (914 mm) sump. Slope of tapered insulation within the sump shall not exceed 4 inches (102 mm) in 12 inches (305 mm).
3) Extend the roofing membrane over the drain opening. Locate the drain and cut a hole in the roofing membrane directly over the drain opening. Provide a 1/2 inch (13 mm) of membrane flap extending past the drain flange into the drain opening. Punch holes through the roofing membrane at drain bolt locations.

4) For cast iron and aluminum drains, the roofing membrane shall be set in a full bed of water block on the drain flange prior to securement with the compression clamping ring. Typical water block application is one 10.5-ounce (315 g) cartridge per drain.
5) Lap seams shall not be located within the sump area. Where lap seams will be located within the sump area, a separate roof membrane drain flashing a minimum of 12 inches (305 mm) larger than the sump area shall be installed. The roof membrane shall be mechanically attached 12 inches (305 mm) on center around the drain with screws and plates. The separate roof drain flashing shall be heat welded to the roof membrane beyond the screws and plates, extended over the drain flange, and secured as above.
6) Tighten the drain compression ring in place.

L) Roof Scupper
1) General
(a) The scupper insert piece generally includes a fabricated welded metal sleeve using PVC coated metal or a pre-molded PVC insert piece.
2) Installation
(a) The PVC wall flashing membrane must be installed prior to scupper insert.
(b) Cut a hole over the center of the drain scupper area.
(i) The hole should be as large as the drain pipe.
(c) Install the drain insert into the hole
(d) Apply water resistant sealant between flange of scupper insert and PVC membrane adjacent to drain pipe.
(i) Use minimum of ¼ tube per drain.
3) The interior of the flange is required to be flashed if scupper insert is not watertight.
(a) All corners of the flanges must be rounded
(b) Never reuse existing scuppers for reroofing projects
(c) Scupper insert flanges may be fastened using plates and fasteners.
4) Heat weld a piece of PVC membrane to the flange and onto the field membrane.
5) All scrim exposed cut edges to be sealed with appropriate and compatible PVC sealants.

XII) TEMPORARY CUT-OFF

A) All flashings shall be installed concurrently with the membrane to maintain a watertight condition as the work progresses. Provide temporary cut-offs around exposed edges and at incomplete flashing areas from the new membrane to the structural deck or existing waterproofing. Remove the cut-offs completely before proceeding with subsequent work.
B) If inclement weather occurs while a temporary cut-off is in place, the Applicator shall provide the labor necessary to monitor the situation to maintain a watertight condition.

XI) ELECTRONIC LEAK DETECTION (ELD) SYSTEM INITIAL TEST

A. Engage Installation and Testing Firm to perform membrane leak testing. Perform testing in accordance with leak detection system manufacturer's recommendations.
1. Perform testing following adequate precipitation or wet membrane adequately to enable accurate testing.
2. Identify locations of membrane leaks; record locations and document with photographs. Submit test reports to Architect.
3. Confirm completed repair of identified leaks and retest to verify water tightness of membrane.

XIII) PROTECTION LAYER – PAVED SYSTEMS

A) Protection Fleece
1) Roll out protective fleece (HG 3320) on top of waterproof membrane roofing. Overlap seams a minimum of 4 inches along sides and 12 inches along ends. Wet fabric as necessary to provide short-term ballast. For long term ballast use sandbags or paver slabs. Never cut near the roofing membrane when cutting fabric for installation. Only cut fabric using industrial shears, and never with a utility knife.

XIV) DRAINAGE LAYER – POURED IN PLACE CONCRETE

A) Paving Drain [HG 3530 and/or 3540]

1) Install drainage composite directly over HG 3320 Protective Fleece.
2) Neatly trim drainage composite to fit closely around penetrations and at the base of all drains to ensure that water will flow freely from composite into drain openings.
3) All cut edges of the drainage composite shall be covered to protect the waterproofing membrane from damage.
4) Promptly proceed with installation of poured in place concrete.

XV) VEGETATED ROOFING SYSTEM

A) Protection Fleece/Water Retention Mat(s)
   1) Roll out protective fleece (HG 3320) on top of waterproof membrane roofing. Overlap seams a minimum of 4 inches along sides and 12 inches along ends. Wet fabric as necessary to provide short-term ballast. For long term ballast use sandbags or paver slabs. Never cut near the roofing membrane when cutting fabric for installation. Only cut fabric using industrial shears, and never with a utility knife.

B) Drainage/Retention Board
   1) Be sure to orient drainage board smooth side up for Semi-Intensive board [HG 3616]).
   2) Install boards starting at roof drains and work towards high elevations. Overlap boards similar to shingles to ensure continuous drainage to outlets. Overlap edges by interlocking 1-2 rows of cups. Overlap area should total approximately 8% of roof area and be uniform throughout.
   3) When cutting boards use only a portable table saw for efficient use of all material and to ensure crisp edges upon cutting. Cut along valley between cups. Never use a utility knife.

C) Filter Fleece
   1) Roll out filter fleece on top of drainage/retention board. Overlap seams a minimum of 4 inches along sides and 12 inches along ends. Wet fabric as necessary to provide short-term ballast. For long term ballast use sandbags or paver slabs. Only cut fabric using industrial shears, and never with a utility knife. Never cut near the roofing membrane when cutting fabric for installation.

D) Edge Restraints
   1) Type: Semi-Intensive Aluminum Edge [HG 3930] & Intensive Aluminum Edge [HG 3940] (as specified on plans for total growth media depth):
      (a) Lay edge profile sections end to end on top of the protective fleece layer.
      (b) Corner pieces to be used for 90-degree corners. Corners of any angle may be formed by cutting the edging on site.
      (c) Follow the submitted edge installation plan to ensure correct mix of male and female pieces are used. This includes all corners and radiuses. Adjustments to be expected as growing media is being installed that edging remains in the indicated areas on the submitted edge installation plan.
      (d) Connect edge pieces and corners with provided connectors.
      (e) Make sure edging does not come in direct contact with base waterproofing membrane.
      (f) Tools: Rubber or rawhide hammer.
   2) Type: Semi-Intensive Aluminum Edge [HG 3930] & Intensive Aluminum Edge [HG 3940] (as specified on plans for total growth media depth):
      (a) Place separation/protective layer between membrane and edge restraints as deemed acceptable by membrane manufacturer.
      (b) Lay edge profile sections end to end on top of the separation/protective layer.
      (c) Corner pieces to be used for 90-degree corners. Corners of any angle may be formed by cutting the edging on site.
      (d) Follow the submitted edge installation plan to ensure correct mix of male and female pieces are used. This includes all corners and radiuses. Adjustments to be expected as growing media is being installed that edging remains in the indicated areas on the submitted edge installation plan.
      (e) Connect edge pieces and corners with provided connectors.
      (f) Secure edge restraint system to deck or waterproofing.
      (g) Tools: Rubber or rawhide hammer.

E) High Wind Stabilization Grid

1) Roll out high wind stabilization grid on top of filter fleece.
2) Overlap seams a minimum of 4 inches along sides and 12 inches along ends.
3) Secure seams together with high tensile strength cable ties.
   (a) Parapet wall height:
      (i) 42 inches = 48 inches on center
      (ii) 18-42 inches = 24 inches on center
      (iii) 0-18 inches = 12 inches on center
4) Secure high wind stabilization grid to edge restraints and/or approved metal flashings with high tensile strength cable ties.

F) Drain/Access Box
1) In the case that drainage board is installed adjacent to the drains then the drain/access boxes are to be placed directly over top of the board.
2) In the case that a drainage stone is used the drain/access boxes should be placed directly on the protective fleece with the drainage stone abutting the outside walls.
3) In the case of inverted roofs, the inspection boxes are placed on the thermal insulation. Following this, a separation ring is installed, which is filled with gravel thus forming the gravel strip surrounding the inspection box.
4) Great care should be taken to ensure the continuity of the filter fleece surrounding the inspection boxes. It is advisable to run the filter-fleece at least 4" up along the sides of the inspection boxes and wrap them over the top rim so that the inspection box cover will hold it in place.
5) When connecting drain/access boxes to high wind stabilization grid, utilize one high tensile strength cable tie for each side when attaching it to stabilization grid.

G) Growth Media
1) Growth media to be placed carefully to avoid damage or displacement of other materials such as edge restraints, filter fleece and drainage components.
2) Spread growth media to the depths as specified on the roofing, landscaping and/or green roofing plans with a variation of no more than 1/2". Ensure that growth media does not get under the layers of filter fleece, between filter fleece overlap, or into drainage/retention board cups. Finish depth of media to be verified by manufacturer prior to vegetation installation.
   (a) Apply Bio-Stimulant and Bio-Fertilizer soil amendments over approved growth media depth.
3) Growth media can be shipped in a variety of forms depending on logistics.
   (a) 50 lb. Bags: For small applications such as many residential projects
   (b) Supersacks: 2 Cubic Yards. Ideal for larger vegetated roofs. The load bearing capacity of the roof must be considered before unloading bags on top of roof. Access and operation of a crane must also be considered for this application.
   (c) Blowing Trucks: The granulometric distribution may change depending on the source material. A watering arrangement may be used to keep the growing media moist and prevent erosion.
   (d) Only use flat-edge plastic shovels & landscaping rakes for placement, movement, and leveling of growth media, all other tools must be approved by manufacturer for use.
4) If there is spillage of growth media into drainage/retention board or subsequent layers beneath, use a portable shop vacuum to ensure that debris is removed and placed appropriately.

H) Perennial Plugs and/or Specified Plantings
1) Plant all specified nursery stock plantings in accordance with approved landscape design.
2) If more than 24 hours has elapsed since installing and soaking the growth media, thoroughly re-soak growth media prior to commencing planting the plugs.
3) Consult drawings for plug planting layout and rate.
4) If an erosion / wind netting is required, make cuts in the erosion / wind netting as required to insert the plugs.
5) Set plugs into the growth media to their full depth and then press the growth media firmly around the installed plug. At the end of each day of planting, soak those areas that have been newly planted.

I) Walkway Pavers and Pedestals
1) Surface on which the pedestals will be placed must be capable of supporting load, clean and free of debris.

2) The finished elevation less the paver thickness shall be established and marked around the perimeter with laser leveling devices
3) Protective fleece is to be rolled out over the entire area to receive paver pedestals. Overlap seams by 12-18". Staged installation of the product is recommended as the paver/pedestals are being installed. This is to prevent the wind uplift of the material prior to the ballasting of the protective fleece with the paver/pedestal system.
4) For installation of pavers in large areas, a paver shall be installed onto 4 pedestals at dispersed locations at every 2000 square feet. The paver shall be installed at the correct elevation using a laser leveling device (or water level) and serve as a reference point to verify the exact elevation of the remaining pavers.

J) Drainage Stone
1) Stone to be installed over protective fleece in drainage zones. Be sure protective fleece is covering all portions of the membrane, overlap seams 6" and but tight against edge restraints.

XVI) FIELD QUALITY CONTROL

A) Manufacturer's Field Service: Engage Division 07 membrane roofing manufacturer's authorized service representative to provide inspection of vegetated roof assembly installation and prepare inspection reports.
B) Electronic Leak Detection (ELD) Assembly Test: Repeat leak detection test following installation of above-membrane components.
1) Engage Installation and Testing Firm to perform membrane leak testing. Perform testing in accordance with leak detection system manufacturer's recommendations.
2) Perform testing following adequate precipitation or wet membrane **[**and membrane overburden**]** adequately to enable accurate testing.
3) Identify locations of membrane leaks; record locations and document with photographs. Submit test reports to Total System Provider and Architect.
4) Confirm completed repair of identified leaks and retest to verify water tightness of membrane.
C) Correct deficiencies in work that do not comply with requirements.

XVII) PLANT MAINTENANCE

A) Provide contractors' Greenformation® plan for proposed maintenance activities after installation. Owner may also submit maintenance plan to maintain manufacturer warranty. Contact adgreenroof.com for specific information.
B) General: During maintenance period, maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing devices, resetting plants to proper elevations or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep plantings free of insects and disease.
C) Periodically check on soil depth and moisture levels across the planted area. Add growing media to system as needed.
D) Apply treatments as required to keep plant materials, planted areas, and growing medium free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Utilize Greenformation® response to the problem. Treatments may include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
E) Use only products and methods acceptable to membrane roofing manufacturer.
F) **Provide Greenformation® sample maintenance plan for proposed maintenance activities after installation.**

XVIII) CLEANING AND PROTECTION

A) During planting and maintenance, keep adjacent areas and construction clean and maintain work area in an orderly condition.
B) Protect Vegetated Roof Assemblies from damage due to planting operations and operations of other contractors and trades. Repair or replace damaged Vegetated Roof Assemblies.

END OF SECTION