SECTION  – thermoplastic olefin (tpo) roofing

1. General
   1. SUMMARY
      1. This Section includes requirements for supply and installation of a fully adhered conventional installation using reinforced thermoplastic membrane roofing system.
      2. Section Includes:
         1. Deck Sheathing Board.
         2. Vapour Retarder.
         3. Roof Insulation.
         4. Insulation Overlay Board.
         5. Leak Detection System œ Electric Field Vector Mapping (EFVM) or Electric Gradient Leak Location (EGLL).
         6. Fully adhered TPO Membrane with Base Flashings.
         7. Accessory Items.
         8. Garden Roofing System.
         9. Sheet Metal Flashings related to roofing, including parapet and cap flashings.
      3. Related Requirements:
         1. Section 05 50 00 – Metal Fabrications.
         2. Section 06 10 00 – Rough Carpentry.
         3. Section 07 21 00 – Thermal Insulation.
         4. Section 07 62 00 – Sheet Metal Flashing and Trim.
         5. Section 07 72 33 – Roof Hatches and Accessories.
         6. Section 07 92 00 – Joint Sealants.
   2. reference standards
      1. American Society for Testing and Materials (ASTM):
         1. ASTM D 6878/D 6878-11a, Standard for Thermoplastic Polyolefin Roofing.
      2. Underwriters Laboratories of Canada (ULC):
         1. CAN/ULC S704-11, Thermal Insulation, Urethane and Isocyanurate, Boards, Faced.
         2. CAN/ULC S770-09, Standard Test Methods for Determination of Long-term Thermal Resistance of Closed-Cell Thermal Insulating Foams.
      3. Canadian General Standards Board (CGSB):
         1. CAN/CGSB-51.33-M89, Vapour Barrier Sheet, Excluding Polyethylene, for Use in Building Construction.
      4. Factory Mutual Research Corporation, Current Edition Approval Guide, Roof Coverings.
      5. Canadian Roofing Contractors' Association (CRCA)
         1. Roofing Specification Manual - Modified Bituminous Membranes Section.
         2. CCMC Listing 13206-R - Evaluation for Thermoplastic Polyolefin.
   3. SYSTEM PERFORMANCE
      1. Roofing System: Prevent water migration from entering building through the roof membrane.
      2. Supply roofing materials from a single manufacturer, from roof deck to roof membrane, to ensure all system components are compatible and warranties can be achieved. Garden roofing materials shall be supplied by garden roofing manufacturer approved to work with roofing systems manufacturer, as not to affect warranty of roofing system manufacturer.
      3. System must meet or exceed FM Class 1-60 or be endorsed with Manufacturer's Wind Speed Warranty for any given Wind Zone location in Canada and all applicable codes.
      4. Comply with and verify requirements that this system satisfies FM wind uplift requirements, Roofing Manufacturer's recommendations and all applicable codes. Contractor is responsible for obtaining applicable FM wind isotachs and Building Code hourly wind velocity pressure for 1 in 50-year return value, necessary for the selection of the proper roof system design specific to this Project as follows:
         1. For projects located where the hourly wind velocity is less than 0.60 kPa, the maximum membrane sheet width shall be 3048 mm (10'). Provide roof system that meets FM 1-60 wind uplift rating. Provide a membrane manufacturer warranty with minimum wind speed warranty of 72-mph.
         2. For projects located where the hourly wind velocity pressure is equal to or greater than 0.60 kPa, but less than 0.80 kPa, the maximum membrane sheet width shall be 2439 mm (8'). Provide roof system that meets FM 1-90 wind uplift rating. Provide a membrane manufacturer warranty with minimum wind speed warranty of 72-mph.
         3. For projects located where the hourly wind velocity pressure is equal to or greater than 0.80 kPa, but less than 0.95 kPa, the maximum membrane sheet width shall be 2439 mm (8'). Additional membrane securement is required at mid span of the 2439 mm (8') wide field sheets. Fasten a 254 mm (10") wide pressure-sensitive reinforced securement strip beneath the field sheets in lieu of plates and fasteners installed through the roof membrane. Provide roof system that meets FM 1-105 wind uplift rating. Provide a membrane manufacturer warranty with minimum wind speed warranty of 80-mph.
         4. For projects located where the hourly wind velocity pressure is equal to or greater than 0.95 kPa, the maximum membrane sheet width shall be 2439 mm (8'). Additional membrane securement is required at mid span of the 2439 mm (8') wide field sheets. Fasten a 254 mm (10") wide pressure-sensitive reinforced securement strip beneath the field sheets in lieu of plates and fasteners installed through the roof membrane. Provide roof system that meets FM 1-135 wind uplift rating. Provide a membrane manufacturer warranty with minimum wind speed warranty of 90-mph.
      5. System must meet ULC S-126 and S-107.
   4. SUBMITTALS
      1. Provide product information in accordance with Section 01 33 00 – Submittal Procedures.
      2. Action Submittals: Provide the following samples before starting any work:
         1. Submit two (2) samples of roofing materials to be used, samples to be standard factory samples.
         2. Garden Roofing Submittals:
            1. Submit two (2) samples of vegetated modules, showing same or similar product grown to maturity, with homogeneous mix of cutting grown plants, with 95 % or greater coverage, as it will be delivered to job site.
            2. Provide two (2) plastic bags, each containing a .25 kg sample of growing medium.
            3. Provide additional agreements of warranty and maintenance contract.
            4. Provide written maintenance protocol.
            5. To ensure proper plant selection and efficient delivery, provide address and contact information of professional horticulturist who will oversee planting and cultivation of modules, within 480 km of Project location.
            6. To ensure efficient and correct use of materials, submit shop drawings indicating layout of modules, and square footage.
         3. Leak Detection System Submittals:
            1. Product Data: For each type of product required for a complete membrane integrity test system.
            2. Shop Drawings: Diagram of proposed system showing complete test area, rooftop structures and equipment, and roof penetrations for building utilities and services. Show location of EGLL system or EFVM integrity test conductor cable, Vector Mapping/Leak Locate Grid, and EFVM connection boxes.
            3. Show Leak Locate System components and locations, and location of Access Enclosure.
            4. Wiring path from Leak Locate and Monitoring System to Access Enclosure.

Termination block and Sub D connector wiring diagram in Access Enclosure.

* + - * 1. Location and size of roof penetrations.
        2. Qualifications: For manufacturer and installing and testing firm.
        3. Field Quality Control Reports: Digital drawings, digital photographic documentation, and written report detailing location and nature of membrane breaches, defects found, and verification of corrective actions taken.
      1. Submit two (2) copies of manufacturer's technical data sheets describing materials' physical properties, explanations about product installation including installation techniques, restrictions, limitations, and other manufacturer recommendations.
      2. Shop Drawings: Submit membrane manufacturer's standard details being used for this Project, indicate changes made to make details project specific; include sloped insulation manufacturers proposed roofing diagrams and layouts for review by the Consultant.
    1. Informational Submittals: Provide the following submittals during the course of the work:
       1. Declaration of Material Compatibility: Provide a written declaration to the Consultant that roofing materials and components are compatible with wall air and vapour retarder membranes.
          1. Provide a written declaration to the Consultant that roofing systems manufacturer's warranty will not be affected by installation of garden roof.
       2. Certificates: Submit installer certificates signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install roofing system.
       3. Site Quality Control Submittals: Copy of roofing system manufacturer's inspection report of completed roofing installation.
  1. project closeout submission
     1. Provide roof [and garden roof] maintenance information in accordance with Division 1 requirements: operations and maintenance information.
     2. Leak Detection Systems - Record Drawings: Digital drawings, photographic documentation, and written report detailing installed location of components of membrane integrity test system.
  2. quality assurance
     1. Single Ply Roofing System:
        1. Manufacturer: Company specializing in manufacturing the products specified in this section, with minimum ten (10) years experience.
        2. Applicator: Company specializing in applying single ply roofing, with minimum five (5) years documented experience and approved by materials manufacturer for guaranteed work.
     2. \*\*\*\*\*\*Garden Roofing System:
        1. Manufacturer: Company specializing in manufacturing the products specified in this section, with minimum five (5) years experience.
        2. Applicator: Company specializing in tray garden roofing system installation, with minimum five (5) years documented experience and approved by materials manufacturer for guaranteed work. Provide certificate of completion of training issued by green roof system manufacturer.
     3. \*\*\*\*\*\*Leak Detection System:
        1. Manufacturer's Qualifications: Manufacturer of membrane integrity test systems with minimum five (5) year record of satisfactory manufacturing and support of installed systems comparable to system required as Work of this Section.
        2. Installing and Testing Firm Qualifications: Approved or certified by membrane integrity test system manufacturer, with minimum five (5) year record of satisfactory experience.
     4. Work of this Section to conform to manufacturer's instructions manual.
  3. REGULATORY REQUIREMENTS
     1. Fire Hazard Classification: ULC Underwriters Laboratories of Canada Class A, S-126 and S-107.
     2. Minimum FM (Factory Mutual Research Corporation) 1-60 for wind and FM Class 1 for fire.
  4. PRE-INSTALLATION CONFERENCE
     1. Convene a pre-installation conference at the site, one (1) week prior to commencing Work of this Section. Require attendance of parities directly affecting Work of this Section, including, but not limited to, the Owners representative, Consultant, Contractor, Roofing Inspector, Roofing Applicator and Job Foreman, Plumber and Roofing Manufacturers Representative.
     2. Contact Consultant two (2) weeks prior to pre-installation conference to confirm schedule.
     3. Review preparation and installation procedures and co-ordinating and scheduling required with related work.
     4. Coordination of Leak Detection System:
     5. Integrate layout of membrane integrity test system with rooftop structures and equipment and roof penetrations for building utilities and services.
        1. Coordinate membrane integrity test system with Work of other Sections.
        2. Pre-installation Meetings: Conduct pre-installation meeting in coordination with the roofing pre-installation conference to verify Project requirements, manufacturer's installation instructions, and coordination with installation requirements for membrane, and vegetative roof assemblies.
     6. Record discussions of conference and decisions and agreements (or disagreements) reached and furnish copy of record to each party attending. Review foreseeable methods and procedures related to roofing work, including the following:
        1. Tour, inspect and discuss condition of substrate, roof drains, roof drain final location, curbs, penetrations, and preparatory work performed by other trades.
        2. Review structural loading limitations of deck and inspect deck for loss of flatness and for required mechanical fastening.
        3. Review structural loading requirements of roofing system for future phased work being installed on the roofing system.
        4. Review roofing system requirements (drawings, specifications, and other contract documents).
        5. Review required submittals, both completed and yet to be completed.
        6. Review and finalize construction schedule related to roofing work and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
        7. Review required inspections, testing, certifying and material usage accounting procedures.
        8. Review weather and forecasted weather conditions, and procedures for coping with unfavourable conditions, including possibility of temporary roofing (if not a mandatory requirement).
        9. Review manufacturer's written design review recommendations.
  5. DELIVERY, STORAGE AND HANDLING
     1. Deliver products to site under provisions of Division 01.
     2. Store and protect products in accordance with manufacturer's instructions.
     3. Protect sheet metal materials from bending, scratching and exposure which would cause corrosion or damage their appearance.
     4. Deliver products in manufacturer's original containers, dry, undamaged and with seals and labels intact.
     5. Store products in weather-protected environment, clear of ground and moisture. Protect all insulation from direct sunlight exposure and the elements with tarps.
     6. Garden Roofing Materials:
        1. Green roof modules are to be delivered in good condition free from shipping damage.
        2. Keep garden roofing modules out of sun if plastic wrapped, to prevent overheating.
        3. Install garden roofing modules within 4 hours of delivery.
        4. During installation, protect the roof deck and membranes with appropriate material such as plywood sheeting. Don't scrape or puncture the slip sheet or membranes. Keep roof surfaces free of soil, grit, or debris at all times with broom. Never set modules on top of soil, dirt, or grit.
  6. ENVIRONMENTAL REQUIREMENTS
     1. Do not apply roofing system during inclement weather.
     2. Do not apply roofing system to dirty, dusty, wet, damp or frozen deck surface.
     3. Review Wind Zone/Uplift Pressure/Wind-Uplift/Wind Design requirements to meet or exceed FM 1-90, whichever is greater.
  7. SEQUENCING AND SCHEDULING
     1. Co-ordinate work as per construction schedule.
     2. Co-ordinate the work of installing associated metal flashings as the Work of this Section proceeds.
  8. WARRANTY
     1. Manufacturer's Warranty: Total System/Labour, Material & Workmanship Warranty, No Dollar Limit, Non-Pro Rated for a period of twenty (20) years from date of Substantial Performance for the Project including; but not limited to, the following components:
        1. Roofing membrane.
        2. Base flashings.
        3. Roofing membrane accessories.
        4. Roof insulation.
        5. Other components of membrane roofing system.
     2. Garden Roofing Manufacturer's Warranty: Manufacturer's standard form covering repair or replacement of garden roofing trays that fails in materials or workmanship within a period of two (2) years from date of Substantial Performance for the Project.
     3. Leak Detection System Manufacturer's Warranty: Manufacturer's standard form covering repair or replacement of membrane integrity test system, which fails in materials or workmanship within a period of two (2) years from date of Substantial Performance for the Project.

1. Products
   1. manufacturers
      1. Basis-of-Design Products: Products named in this Section were used as the basis-of-design for the Project; additional manufacturers offering similar products may be incorporated into the Work of this Section provided they meet the performance requirements established by the named products, and provided that they can offer system warranties indicated in above.
      2. Acceptable Materials Manufacturers: Subject to compliance with requirements specified in this Section and as established by the Basis-of-Design Materials, manufacturers offering products that may be incorporated into the Work include but are not limited to, the following:
         1. Johns Manville.
         2. Firestone Building Products Company.
         3. Carlisle SynTec Incorporated.
         4. Genflex Roofing Systems.
      3. Acceptable Garden Roofing Manufacturers:
         1. LiveRoof.
         2. Carlisle SynTec Incorporated.
         3. Firestone Garden Roofing System.
      4. Acceptable Leak Detection System Manufacturer:
         1. International Leak Detection (ILD).
         2. Detec Systems Ltd.
   2. MATERIALS
      1. Adhesives: Manufacturers recommended adhesives specifically formulated for installation of materials outlined below, meeting the wind resistance rating indicated in this Section.
      2. Deck Sheathing Board: Glass mat faced, mould resistant roof sheathing boards having a treated gypsum core manufactured in accordance with ASTM C 1177/C 1177M-08, and as follows:
         1. Thickness: 13 mm (1/2").
         2. Long Edges: Square.
         3. Location: Roof substrates over steel decks and sheathing for parapets.
         4. Acceptable Materials:
            1. Georgia Pacific DensDeck.
            2. CGC Securock Glass-Mat Sheathing.
            3. CertainTeed GlasRoc Roof Board.
      3. Fasteners to Steel Decking: Cadmium plated flat headed, self tapping screws, No. 12 of Type A or AB, in conformance with CSA B35.3.
      4. Pre-manufactured Vapour Barrier: Modified bituminous, self adhering vapour barrier, designed specifically for installation to deck sheathing board; and having a non-slip and UV resistant surface, as recommended by the roofing manufacturer.
      5. Wood Roof Materials: Refer to Section 06 10 00 – Rough Carpentry.
      6. Insulation:
         1. Primary Flat Insulation: Polyisocyanurate foam rigid board roof insulation consisting of largest panels practical, having square edges, minimum LTTR Value 6/1", total thickness as indicated on Drawings, perpendicular from edge of roof to a minimum thickness of 50 mm (2"); conforming to ULC S704, Type 3, Class 2, with inorganic, coated glass facers manufactured to a tolerance not exceeding 3mm (1/8") from nominal size in any dimension:
            1. Acceptable Materials:

Firestone ISO 95+GL.

Carlisle HP-H.

Atlas ACFOAM III.

* + - 1. Tapered Insulation Acceptable Materials: Tapered to maximum ½" low edge:
         1. Firestone ISO 95+GL Tapered Insulation.
         2. Carlisle HP-H Tapered Insulation.
         3. Atlas ACFOAM III.
      2. Drain Sump:
         1. One-piece, pre-manufactured, polyisocyanurate, 1220 mm x 1220 mm (4 'x 4') Gemini Drain Set, with minimum 13 mm (1/2") per foot of slope, by Atlas Roofing Corporation and represented by Building Resource Inc. Install at all drains.
      3. Tapered Edge Strip:
         1. Pre-manufactured, polyisocyanurate, tapered from 0 mm to 50 mm (0" to 2") in a 610 mm x 2439 mm (2' x 8') board by Atlas Roofing Corporation and represented by Building Resource Inc. Install at all parapets, and other areas as needed and shown on the Drawings.
    1. Insulation Overlay Board: 13 mm (1/2") glass mat faced gypsum board or 13 mm (1/2") glass mat faced HD ISO cover board, moisture, and mould resistant, primed ready for adhered application thermoplastic membrane roofing:
       1. Acceptable Materials:
          1. Georgia Pacific, DensDeck Prime.
          2. Firestone, ISOGard HD.
          3. Carlisle SynTec, SecurShield HD Cover Board.
          4. Atlas ACFOAM HS.
          5. CGC Securock Gypsum-Fiber Roof Board.
    2. Leak detection vector mapping grid, taped to insulation overlay board, prior to membrane installation, as indicated in Paragraph 2.4 below.
    3. Reinforced Thermoplastic Membrane: Reinforced thermoplastic membrane sheet; uniform, flexible sheet formed from thermoplastic olefin; internally reinforced with manufacturer's standard scrim having a minimum nominal membrane thickness over scrim of 0.4 mm (0.016") in accordance with ASTM D 6878, and as follows:
       1. Thickness: 60 mil thickness.
       2. Exposed Face Color: [White][Tan][Grey].
       3. Acceptable Products:
          1. JM TPO by Johns Manville.
          2. Firestone UltraPly TPO by Firestone Building Products Company.
          3. Sure-Weld Reinforced TPO by Carlisle SynTec Incorporated.
    4. Reinforced thermoplastic membrane slipsheet / root barrier: Constructed of same material, thickness, and colour as roofing membrane sheet, as approved by roofing systems membrane manufacturer.
  1. accessories
     1. Provide auxiliary materials recommended by roofing system manufacturer for intended use and compatible with membrane roofing.
     2. Walkway Pads: Manufacturer's standard 762 mm (30") wide x 15240 mm (50') long rolls, complete with slip-resistant textured top surface, and smooth bottom surface, constructed of non-reinforced thermoplastic material.
        1. Basis of Design: UltraPly TPO Premium Walkway Pads by Firestone.
     3. Membrane Flashing: Manufacturer's standard sheet flashing of same material, type, reinforcement, thickness, and color as sheet membrane.
     4. Adhesives and Cleaners: Manufacturer's standard materials specifically formulated for intended purpose including, but not limited to, the following:
        1. Bonding Adhesive.
        2. Cut Edge Sealant.
        3. Water Cut-Off Mastic and Sealant.
        4. Moulded Pocket Sealant.
        5. Weathered Membrane Cleaner.
  2. LEAK DETECTION SYSTEM MATERIALS
     1. System Description:
        1. Vector Mapping Grid: Highly conductive stainless steel wire measurement grid located under membrane and above non-conductive membrane substrate, connected through contact plate and cable to connection box accepting applied low-voltage charge from portable pulse generator.
        2. Membrane integrity test System:
           1. (EFVM) conductor cable, placed on top of membrane, delivering direct current tension to membrane surface, enabling inspection and isolation of points of moisture infiltration through membrane to conductive substrate under membrane.
           2. (EGLL) Leak Locate System; Electrical Conductors: Flat conductors or wire capable of facilitating location of membrane breaches.
        3. Install and terminate electrical cable from Leak Locate and Monitoring System to Access Enclosure.
     2. Materials:
        1. Conductor Cable: Nine strands of 0.06" diameter highly conductive stainless steel wire interwoven with braided polyethylene strands, placed on weather side of membrane:
           1. Basis of Design Product: International Leak Detection, Vector-9 Conductor Wire.
        2. Vector Mapping Grid: Highly conductive, corrosion resistant, geometrically stable mesh, placed between membrane and insulation overlay board.
           1. Stainless Steel Grid: 2" x 2" screen mesh in 47" by 160' rolls.
           2. Basis of Design Product: International Leak Detection, Vector Mapping Grid.
        3. Conductor Wire Assembly: Provide grounding plate for connection to Vector Mapping Grid, suitable for connection to terminals at connection box.
        4. Leak Locate System Sensing Strip: Two flat, tinned copper conductors between two high-dielectric substrates. The bottom substrate contains an adhesive layer; the top non-conductive layer protects the conductors while employing non-hygroscopic properties.
        5. Access Enclosure: A watertight NEMA Enclosure (required for outdoor installations only) with internal PCB panel with Sub D connector terminals and screw terminal barrier blocks for connecting system cable wiring and to provide field test access.
        6. Connection Box: Weatherproof, corrosion-resistant electrical enclosure with permanent terminal connections for connecting diagnostic and testing equipment, NEMA 4 with the following characteristics:
           1. Permanent connections for attachment of diagnostic and testing equipment without opening contact box.
           2. Weatherproof cover to seal terminals when membrane integrity test system is not in use.
           3. Hardware, brackets, and fittings required to permanently mount contact box to building structure.
           4. Basis of Design Product: International Leak Detection, EFVM Connection Box.
        7. Accessories:
           1. Provide corrosion-resistant fasteners and hardware, electrical terminations, sealants, and other items required to provide complete installation.
           2. Lap Joint Tape: Self adhesive aluminum tape, minimum 2" wide.
  3. GARDEN ROOFING SYSTEM MATERIALS
     1. Module Roofing System Characteristics:
        1. Size: 12" x 24" tray; soil height raised to approximately "4" elevation.
        2. Material: 1/8" thick, 100% post-industrial recycled polypropylene.
        3. Colour: Black.
        4. Modules contain positive drain holes placed at lowest point in the module.
        5. Acceptable Materials:
           1. LiveRoof Lite System by LiveRoof.
           2. Hydropack Roof Garden System by Carlisle SynTec Incorporated.
           3. Skyscape System by Firestone.
     2. Soil Characteristics:
        1. Soil Height: Approximately 4".
        2. Monolithic soil continuum, approximately 1-1/4" taller than modules, and shall obscure modules during all 12 months of the year for optimal year-round aesthetic presentation.
        3. Join soil via subterranean moisture portals uniting soil from module to module.
     3. Plants:
        1. Plant material to cover minimum of 95 % of surface area of soil within modules at time of delivery.
        2. Homogeneous mix of cutting highly grown drought resistant ground covers. Include accent plants for enhanced height, texture, or early/late season bloom times.
        3. Module planting and cultivation to occur under supervision of professional horticulturist located within 480 km of Project location.
     4. Accessories:
        1. Edging: L-shaped extruded aluminum edging with perforations for drainage. Edging is 4 1/2" x 3" with a minimum gauge of 1/8". Edging, regardless of type, must allow for adequate drainage via sufficient drain perforations at the bottom of the edging, with sidewalls tall enough to cover the modules and contain the soil.
  4. SHEET METAL FLASHINGS AND TRIM
     1. Prefinished Steel Flashings: 24-gauge spangle free zinc coated sheet steel to ASTM AIM with a coating designation G90 (Z275). Material to be factory primed and top coated as indicated in Section 07 62 00 – Sheet Metal Flashing and Trim.

1. Execution
   1. examination
      1. Verify that surfaces and site conditions are ready to receive work.
      2. Engineer to verify that deck is properly supported, secured and is minimum 22 gauge for steel as per FM Loss Prevention Data Sheet 1-28 and 13 mm (1/2") exterior grade plywood for wood.
      3. Verify that deck is clean and smooth, free of depressions, irregularities, or projections, properly sloped to drains, valleys or eaves.
      4. Verify that deck surfaces are dry and free of dirt and debris. Verify flutes of metal deck are clean and dry.
      5. Start of single ply roofing system work means installer accepts existing surfaces and substrates.
   2. PROTECTION
      1. Protect building surfaces against damage from roofing work.
   3. PREPARATION - METAL DECK
      * 1. Verify that all units are properly secured in place and that deck is clean, ready to receive membrane.
   4. INSTALLATION - SINGLE PLY ROOFING SYSTEM
      1. Deck Sheathing Board: Fasten gypsum board levelling surface into the upper rib surfaces of steel deck as recommended by systems manufacturer.
      2. Install vapour retarder membrane onto dry substrate in accordance with manufacturer's recommended installation instructions, for normal humidity conditions.
         1. Overlap self-adhered roof vapour retarder onto the air and vapour retarder membrane from adjoining walls to ensure total continuity.
         2. Overlap side and end laps in shingle fashion, a minimum of 50 mm (2").
         3. Install self-adhering vapour retarder membrane at insulation perimeters and around each element piercing the insulation to ensure sealed connections with base sheet at up stands.
         4. Apply firm pressure over entire surface of vapour retarder by rolling to ensure full contact to substrate.
            1. Insulation Installation (Conventional Roofing): Apply two (2) layers insulation with joints tightly butted, and with upper surface flush across joints, following layout procedures recommended by manufacturer, in accordance with reviewed shop drawings; fill gaps greater than 6 mm (1/4") wide with insulation.
         5. Cut insulation to fit neatly to perimeter blocking and around all projections through roof.
         6. Apply no more insulation than can be covered with roof membrane on same day.
         7. Vertical joints between level boards and sloped modules, and between two rows of insulation board must be staggered.
      3. Installation of Insulation Overlay (Conventional Roofing): Install membrane underlayment in accordance with manufacturer's written requirements, and as follows:
         1. Firmly set the insulation overlay boards, long joints continuous and short joints staggered. Boards must be evenly and tightly butted together, with joints offset from primary insulation joints.
         2. Apply only as many boards as can be covered by roofing membrane in the same day.
         3. Use manufactures recommended insulation and cover board adhesive. Maximum board size 1220 mm x 1220 mm (4' x 4') set into adhesive and walk boards in for full contact.
      4. Leak Detection - Vector Mapping Grid: Install vector mapping grid on insulation overlay board immediately prior to installation of membrane.
         1. Verify that location of vector mapping grid fasteners does not interfere with or cause damage to membrane.
         2. Fasten vector mapping grid in accordance with leak detection system manufacturer's requirements.
         3. Do not place vector mapping grid where it will be in continuous direct contact with structural components.
         4. Provide minimum 2" overlap where adjacent sheets meet, including side laps and end laps.
         5. Cut vector mapping grid as close as possible to the perpendicular strand at both end and side edges.
      5. Adhered Roofing Membrane Installation: Install roofing membrane over area to receive roofing in accordance with membrane roofing system manufacturer's written instructions and as follows:
         1. Unroll roofing membrane and allow to relax before installing.
         2. Start installation of roofing membrane in presence of membrane roofing system manufacturer's technical personnel.
         3. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer, stagger end laps.
         4. Bonding Adhesive: Apply bonding adhesive at rate required by manufacturer; do not apply bonding adhesive to splice area of roofing membrane.
         5. Adhesively fasten roofing membrane securely at terminations, penetrations, and perimeter of roofing.
         6. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
         7. Clean seam areas, overlap roofing membrane, and hot air weld side and end laps of roofing membrane in accordance with manufacturer's written instructions to ensure a watertight seam installation.
         8. Verify that membrane and penetrations/projections are of a non-conductive material or are electrically insulated by applying additional layers of waterproof insulating materials.
         9. Base Flashing Installation: Install sheet flashings and preformed flashing accessories and adhere to substrates in accordance with membrane roofing system manufacturer's written instructions.
            1. Apply bonding adhesive to substrate and underside of sheet flashing at required rate and allow to partially dry; do not apply bonding adhesive to seam area of flashing.
            2. Flash penetrations and field formed inside and outside corners with sheet flashing.
            3. Clean seam areas and overlap and firmly roll sheet flashings into the adhesive; weld side and end laps to ensure a watertight seam installation.
            4. Terminate and seal top of sheet flashings.
      6. Leak Detection - Current-Sensing Strip or Conductor Wire and Connection Box:
         1. Place peel-and-stick tape with flat conductors in the specified pattern on top of waterproof membrane.
         2. Install conductor wire on top of membrane at spacing and layout indicated on approved shop drawings. Secure conductor wire using method recommended by manufacturer.
         3. Install connection boxes/access enclosures in predetermined locations identified on approved shop drawings. Secure connection boxes using method recommended by manufacturer.
      7. Install slipsheet / root barrier to membrane sheet, complete with overlapped and bonded seems, in accordance with single ply manufacturer's recommendations.
   5. field quality control
      1. Membrane Inspection: After installation of roof membrane and prior to installing garden roofing, the following procedures are required:
         1. The Structural Engineer and garden roofing systems representative shall verify that the roof is properly designed and constructed to adequately support the load of the green roof system.
         2. **[The roof is to be flood tested for water tightness. Water testing shall be witnessed and confirmed in writing by Consultant, and single ply roofing Subcontractor and manufacturer representative.][Conduct a field quality control leak test using leak detection system and flag all defects required for repair. Once roofing membrane has been repaired, retest roofing membrane for integrity. Submit one test and results report to the Owner and Consultant.]**
         3. The roof is to be inspected and determined ready to accept the garden roofing by the garden roof manufacturer's representative.
      2. Notify Consultant 48 hours in advance of date and time of inspection.
      3. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements, at no additional cost to the Owner.
   6. INSTALLATION - GARDEN ROOFING SYSTEM
      1. Module Installation to be conducted:
         1. When plants are properly adapted and acclimatized to local weather conditions.
         2. When weather is above 2 deg C and there is no ice on the roof and engineered soil is unfrozen.
         3. No later than the cut off date required by the green roof system providers warranty terms, if applicable.
      2. Module Installation:
         1. Module installation to follow behind installation of slip sheet/root barrier, and edging.
         2. Module installation to be conducted in strict accordance with manufacturer installation guidelines. Surface to be clean and swept free of soil, dirt, stones or grit before placing each module. Rows to be straight, modules to be tight against each other with edges overlapping and arranged in proper directional orientation.
         3. Module installation to be conducted in accordance with green roof design.
         4. Modules to be placed directly on top of appropriate slip sheet/root barrier.
         5. It is recommended that the cut side of the module be set tight against the edging or toward the side of an intact module so as to prevent soil spillage.
         6. Immediately water modules thoroughly after installation so as to moisten the media from top to bottom.
         7. First maintenance visit to be conducted two (2) weeks after installation is completed.

Delete final inspection if there is no garden roof installed on the project.

* 1. FINAL INSPECTION
     1. Final Roofing Inspection: Once garden roof installation is complete, the following procedures are required:
        1. Garden roofing manufacturer's representative shall verify garden roof modules have been installed tight against each other, in straight rows, corners aligned, properly oriented, and tight against the edging.
        2. Conduct a field quality control leak test using leak detection system and flag all defects required for repair. Once garden roofing overburden and been removed, repair damaged membrane and retest roofing membrane for integrity. Submit one test and results report to the Owner and Consultant.
        3. Replace garden roofing materials back into position as was prior to membrane testing.
     2. Notify Consultant 48 hours in advance of date and time of inspection.
     3. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements, at no additional cost to the Owner. Provide final inspection for issuance of warranty.
  2. PROTECTION AND CLEANING
     1. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction will not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Consultant and Owner.
     2. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and in accordance with warranty requirements.
     3. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION