PART 1 - GENERAL

1.1 SUMMARY

A. Furnish and install a mechanically attached Thermoplastic membrane roofing system. Completed system shall include flashings, accessories, terminations, and other construction necessary to provide a leak-free, ponding-free roofing system.

B. The work included under this section shall be completed in accordance with the Title 24, Part 6, of the California Code of Regulations: California's Energy Efficiency Standards for Residential and Nonresidential Buildings.

1.2 RELATED REQUIREMENTS

Note to Specifier: Retain and edit Paragraphs below to refer to Sections with information that would be expected in this Section.

A. Section 07 60 00 “Flashing and Sheet Metal;” for additional requirements, including shop drawing requirements, for membrane-clad metal.

B. Section 07 92 00 “Sealants and Caulking;” for additional requirements for sealants specified in this Section.

1.3 REFERENCE STANDARDS

A. General: All standards refer to the latest edition or revision, unless otherwise noted.

2. ASCE – 7: American Society of Civil Engineers
3. ANSI: American National Standards Institute
4. SPRI: Single Ply Roofing Industry
5. NRCA: National Roofing Contractors Association
7. UL: Underwriters Laboratories, Incorporated.
1.4 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: At least two working days prior to starting the application of the roofing system and insulation, conduct and coordinate a preinstallation meeting with Stanford University.

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 SUBMITTALS

Note to Specifier: Insert submittal procedures Section number and title below.

A. Comply with pertinent provisions of Section______.

B. Within 15 calendar days after the Contractor has received the Notice to Proceed, submit:
   1. Materials list of items proposed to be provided under this Section;
   2. Manufacturer’s specifications and other data needed to prove compliance with the specified requirements;
   3. Shop Drawings in sufficient detail to show fabrication, installation, anchorage, and interface of the work of this Section with the work of adjacent trades.

C. Product Data: For each type of product indicated.

D. Shop Drawings: For roofing system. Include plans, elevations, sections, details,
and attachments to other work. Include flashings, tie-ins, edges, terminations, expansion joints, penetrations and joints. Provide shop drawings for assemblies indicated below.

1. Layout and quantity of walkway pads. Include plans, dimensions, connection to roof, and relationship to adjacent roofing appurtenances.
2. All membrane-clad sheet metal configurations.
3. Layout of crickets including, but not limited to, slope, heights from drain, connections/securement to structural deck.

E. Samples for Initial Selection: For the following products:

**Note to Specifier: Edit below for items actually specified in this Section.**

1. Membrane roofing, of color specified.
2. Membrane-clad metal, in color selected.

F. Samples for Verification: Samples of each primary component to be used in the roofing system including, but not limited to, the following:

**Note to Specifier: Edit below for items actually specified in this Section.**

1. Membrane roofing, of color specified.
2. Membrane-clad metal, in color selected.
3. Flashing materials.
4. Sealant, full size tubes.
5. Fasteners and plates, each type used.

G. Certificates: Signed by manufacturer certifying that installer is a factory authorized certified applicator in good standing with the manufacturer and is qualified to perform the specified work and able to receive the required warranty.

H. Certifications: Installer work history data of successful warranted installations similar to that of this Project.

I. Certificates: Signed by roofing manufacturer certifying that roofing system complies with requirements specified in "Performance Requirements" Article.

J. Certificates: By manufacturers of roofing and accessory materials that all materials supplied comply with all requirements of the identified ASTM and industry standards or practices.

K. Certificates: From the applicator that the system specified meets all identified code and insurance requirements as required by the Specification.

L. Test Reports: UL Class A Fire Resistance approval.

M. Field quality-control reports.
N. Sample Warranties: Sample copies of manufacturer and contractor warranties.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data.

B. Warranty Documentation.

1.7 EXTRA STOCK MATERIALS

A. Furnish extra materials described below that are from same production run (batch mix) as materials applied and that are packaged for storage and identified with labels describing contents.
   1. Furnish one roll of roofing material.
   2. Furnish six full size tubes of sealant.

1.8 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer shall meet or exceed the qualifications listed below and indicated elsewhere in the Contract Documents.
   1. Manufacturer shall be capable of providing field service representation during construction, approving an acceptable installer, recommending appropriate installation methods, and conducting a final inspection of the thermoplastic membrane roofing.
   2. Final inspection for issuance of warranty shall be by a technical representative employed by roofing system manufacturer specifically to inspect installation for warranty purposes.
   3. Contractor to submit copies of reports to the Architect and Stanford University within 7 days of the site visit.

B. Installer Qualifications: Installer shall meet or exceed the qualifications listed below and indicated elsewhere in the Contract Documents.
   1. A qualified firm that is authorized by the membrane manufacturer prior to execution of agreement with minimum five years of documented experience as a certified applicator to install manufacturer's products for the specified warranty.
   2. Installer personnel trained and authorized by the manufacturer shall complete all work pertaining to the installation of the Work of this Section, including membrane and flashings.
   3. Use adequate amounts of such qualified workmen who are thoroughly trained in the crafts and techniques required to properly install the type of roofing system specified and other work required to complete the Work specified and within the specified time.

C. Materials: For each type of material required for the Work of this Section, provide materials which are the products of the roofing manufacturer. For products indicated that are not manufactured by the roofing manufacturer,
provide products approved by the roofing manufacturer.

D. Suitability of Contract Documents: Verify that the Contract Documents are workable and not in conflict with the manufacturers’ recommendations and instructions prior to the start of the Work. Start of the Work constitutes acceptance of project conditions and requirements.

E. Thermoplastic membrane roofing and associated Work shall be in compliance with NRCA recommendations. Where requirements of the Contract Documents are more stringent, the more stringent shall apply.

1.9 REGULATORY REQUIREMENTS

A. Conform to California Building Code for roof assembly, fire hazard requirements and balance of requirements on the Project.

B. Conform to applicable City, County, State, and Federal requirements.

C. Submit evidence that the proposed roof system meets the requirements of the local building code and has been tested and approved or listed by the following test organizations. These requirements are minimum standards and no roofing work shall commence without written documentation of the system’s compliance.
   1. American Society of Civil Engineers - ASCE-7
   2. Underwriters Laboratories, Inc. - Class A assembly

D. Conform to the requirements of the following regulatory agencies:
   1. OSHA
   2. EPA
   3. Local City and County Authorities

E. The Contractor shall be responsible for obtaining necessary permits for demolition of existing roof and installation of new roofing. Coordinate the required government inspections with the local authorities.

1.10 DELIVERY, STORAGE AND HANDLING

Note to Specifier: Insert delivery, storage and handling Section number and title below.

A. Comply with pertinent provisions of Section_______.

B. Deliver the materials to the job site in the manufacturer’s unopened containers with all labels intact and legible at time of use. Sequence deliveries to avoid delays, but minimize on-site storage.
   1. Indicate conformance with reference standard applicable to the material.
   2. Bear UL and FM labels unless otherwise approved by Owner.
C. Store and handle materials in accordance with the manufacturer’s published requirements, Contract Documents and in accordance with Stanford University’s requirements. The more stringent requirements shall apply.

D. Maintain the products in a dry condition during delivery, storage, handling, installation, and concealment.

E. Protect from damage including, but not limited to, from sunlight, weather, excessive temperatures and construction operations. Remove damaged material from the site and dispose of in accordance with applicable regulations. Materials which are determined to be damaged by the Architect, Stanford University or the manufacturer are to be removed from the job site and replaced at no cost to Stanford University.

F. Do not overload roof. Load goods so as not to cause structural damage or failure, or create a safety hazard.

1.11 PROJECT CONDITIONS

A. Perform work only when existing and forecasted weather conditions are within the limits established by the manufacturer of the materials and products used. Do not apply roofing to damp or wet substrates.

B. Proceed with installation only when substrate construction and preparation work is complete and in condition to receive roofing.

C. Only as much of the roofing as can be made weathertight each day, including all flashing and detail work, shall be installed. All seams shall be cleaned and heat-welded before leaving the job site that day.

D. All work shall be scheduled and executed without exposing the interior building areas to the effects of inclement weather. The existing building and its contents shall be protected against all risks.

E. New and temporary construction, including equipment and accessories, shall be secured in such a manner as to preclude wind blow-off and subsequent roof or equipment damage.

F. Uninterrupted waterstops shall be installed at the end of each day’s work and shall be completely removed before proceeding with the next day’s work. Waterstops shall not emit dangerous or unsafe fumes and shall not remain in contact with the finished roof as the installation progresses. Contaminated membrane shall be replaced at no cost to Stanford University.

G. Arrange work sequence to avoid use of newly constructed roofing as a walking surface or for equipment movement and storage. Where such access is absolutely required, provide all necessary protection and barriers to segregate the work area and to prevent damage to adjacent areas. A substantial protection
layer consisting of plywood over insulation board shall be provided for all new and existing roof areas which receive rooftop traffic during construction.

1.12 WARRANTY

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

Note to Specifier: Verify available warranties and warranty periods for roofing system with manufacturers listed in Part 2 articles.

B. Manufacturer System Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system including components that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: ________ years from date of Substantial Completion.

C. Installer Warranty: Installer’s workmanship warranty in which installer agrees to repair or replace components of membrane roofing system including, but not limited to, roofing, flashing, substrate board, insulation and accessories, that fail in materials or workmanship within the specified warranty period.
   1. Warranty Period: ________ years from date of Substantial Completion.
   2. The bonding company must also cover the first year of warranty.
   3. Warranty shall include all corrective actions necessary to repair damage to the roof membrane and components caused by roof leaks or improper application
   4. Warranty shall cover damage to building and contents resulting from failure to resist penetration of water.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

In other Part 2 Articles, the following requirements apply to product selection:
   1. Products: Subject to compliance with requirements, provide one of the products specified or approved equal.

2.2 PERFORMANCE CRITERIA

Note to Specifier: Retain first paragraph below for roofs that must comply with the DOE’s ENERGY STAR requirements.
A. Energy Performance: Provide roofing system that is listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

Usually retain paragraph below for roofs that must comply with California Energy Commission’s CEC-Title 24. Options are values required for low-slope roofs by prescriptive approach; insert other values if required for building-envelope trade-off approach or whole-building performance approach. A list of products tested according to CRRC-1 with their test values is available in PDF at www.coolroofs.org.

B. Wind Uplift Performance: Provide assembly meeting wind uplift resistance for field, perimeter and corners in accordance with ASCE-7.

C. Standard Test Methods for Fire Tests of Roof Coverings: Class A; UL 790

2.3 THERMOPLASTIC MEMBRANE

A. Basis-of-Design Product: Subject to compliance with requirements, provided Firestone Incorporated: 60 mils; 10 percent nominal tolerance not permitted. Membrane shall be within 2 mils.

B. Source Limitations: Obtain components including roof insulation and fasteners for roofing system from the same manufacturer as the membrane roofing or manufacturer approved by the membrane manufacturer.

Note to Specifier: Do not specify white roof color for replacement of existing roofing that is not white. Other colors are available. Confirm roofing membrane color meets energy requirements. Edit performance criteria accordingly.

1. Exposed Face Color: White unless otherwise noted.

C. Other Acceptable TPO Membrane Roofing Systems:

1. Carlisle Sys Tec Inc.
2. GAF Materials Corporation
3. Johns Manville
4. Versico Incorporated
5. Firestone

Note to Specifier: Do not specify white roof color for replacement of existing roofing that is not white. Other colors are available. Confirm roofing membrane color meets energy requirements. Edit performance criteria accordingly.

1. Exposed Face Color: White unless otherwise noted.

D. Membrane Performance Criteria: Criteria for the TPO roofing membrane includes, but is not limited to the following:
General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.

1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.

E. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.

F. Roofing System Design: Tested by a qualified testing agency to resist the following uplift pressures:

1. Corner Uplift Pressure: Refer to structural drawings.
2. Perimeter Uplift Pressure: Refer to structural drawings.
3. Field-of-Roof Uplift Pressure: Refer to structural drawings.

G. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a built-up roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.

1. Fire/Windstorm Classification: Class 1A-90.
2. Hail-Resistance Rating: MH.

H. Solar Reflectance Index: Not less than 78 when calculated according to ASTM E 1980, based on testing identical products by a qualified testing agency.

I. Energy Star Listing: Roofing system shall be listed on the DOE's ENERGY STAR "Roof Products Qualified Product List" for low-slope roof products.

J. Fire-Resistance Ratings: Comply with fire-resistance-rated assembly designs indicated. Identify products with appropriate markings of applicable testing agency.

K. Factory welds are not permitted for field membrane.

2.4 AUXILIARY MEMBRANE ROOFING MATERIALS

A. General: Auxiliary membrane roofing materials recommended by roofing system manufacturer for intended use, and compatible with membrane roofing.
1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.

2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   a. Plastic Foam Adhesives: 50 g/L.
   b. Gypsum Board and Panel Adhesives: 50 g/L.
   c. Multipurpose Construction Adhesives: 70 g/L.
   d. Single-Ply Roof Membrane Adhesives: 250 g/L.
   e. TPO Welding Compounds: 510 g/L.
   f. Adhesive Primer for Plastic: 650 g/L.
   g. Single-Ply Roof Membrane Sealants: 450 g/L.
   h. Nonmembrane Roof Sealants: 300 g/L.
   i. Sealant Primers (Nonporous Substrates): 250 g/L.
   j. Sealant Primers (Porous Substrates): 775 g/L.

3. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the testing and product requirements.

4. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

5. Other Adhesives: As recommended by membrane manufacturer.

B. Manufactured Fascias, Copings, Gutters And Downspouts: Refer to Section 077100, “Roof Specialties.”

C. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils thick, minimum, of same color as TPO sheet.

D. Bonding Adhesive: Manufacturer's standard, water based.

E. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.

F. Thermoplastic Membrane Flashing: Manufacturer's standard sheet flashing of same material, thickness, and color as TPO sheet membrane.

G. Membrane Clad Metal: Manufacturer’s 24 gauge G90 hot dip galvanized steel with manufacturer’s unreinforced 20 mil TPO membrane laminated on one side.

H. Oil Resistant Sheet Flashing: Manufacturer's standard oil resistant sheet flashing of same material, type, reinforcement, thickness, and color as TPO sheet membrane.
I. Bonding Adhesive: Manufacturer's standard, vertical surface adhesive.

J. Sealant: Manufacturer’s standard, one-part sealant.

K. Membrane Cleaner: Manufacturer’s standard cleaner for the removal of contaminants from the membrane.

L. Slip Sheet: Manufacturer's standard, of thickness required for application.

M. Wormgear Clamp: 100 percent type 316 stainless steel wormgear clamp.

N. Fasteners: Factory-coated corrosion resistant steel fasteners and metal plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening membrane and components to substrate, and acceptable to membrane roofing system manufacturer, to achieve wind uplift requirements for project.

O. Fasteners for Membrane Clad Metal: Hot-dip galvanized ring shank nails by Maze Nails or equal of sufficient length to penetrate wood substrate 1-1/4 inch.

P. Pipe Supports: Erico Caddy Rooftop Supports, or approved equal. Provide base, slotted metal channels, and components to secure piping.

Q. Membrane Walkway Pads: Manufactured or recommended by membrane manufacturer.

R. Miscellaneous Accessories: Provide flashing adhesive, sheet flashing membrane, preformed inside and outside corner sheet flashings, T-joint covers, aluminum tape and other accessories for a complete installation.

PART 3 - EXECUTION

3.1 GENERAL

A. Install Thermoplastic membrane roofing system with positive slope to drains, free of standing (ponding) water.

B. Conduct fastener pullout tests performed by or in the presence of the manufacturer’s technical representative in accordance with the latest revision of the SPRI/ANSI Fastener Pullout Standard to verify condition of deck/substrate and to confirm expected pullout values. Testing shall be performed on walls and in the field of the roof.

C. Verify that all roof drain lines are functioning correctly (not clogged or blocked) before starting work. Contractor shall report any such blockages in writing to the Architect for corrective action prior to roof system installation.
D. No bitumen shall be in contact with the membrane.

3.2 SUBSTRATE CONDITION

A. Contractor shall be responsible for acceptance or provision of proper substrate and underlying roofing components to receive roofing materials.

B. Contractor 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 and nailers are properly secured and prepared to receive roofing materials.
   3. Surfaces are smooth and free of dirt, debris and incompatible materials.
   4. Surfaces are free of standing water and visible moisture.

C. Rotted or deteriorated wood shall be removed and replaced. Deck type and attachment shall conform to local code requirements. Fastener heads shall be recessed into the wood surface.

D. The substrate shall be continuous, clean, smooth, dry, free of flaws, sharp edges, loose and foreign material, oil and grease and be structurally sound. Sharp ridges, other projections and accumulations of bitumen above the surface shall be removed to ensure a smooth surface before roofing. The roof shall be installed and cured in accordance with industry standards. Roofing shall not start until all defects have been corrected.

3.3 SUBSTRATE PREPARATION

A. The roof deck and roof construction must be structurally sound to provide support for the roofing system. The contractor shall load materials on the rooftop in such a manner to eliminate risk of deck overload due to concentrated weight.

B. Substrate shall be inspected prior to installation of roofing. Prepare surface to have a smooth and level finish and be free of dust, excess moisture, oil-based curing agents, and loose debris. Sharp ridges or other projections above the surface shall be removed before roofing.

C. Broken, delaminated, wet or otherwise damaged materials shall be removed and replaced at no cost to Stanford University.

D. Pull-out Tests: Perform pull-out tests to determine appropriate rate and type of fastener installation in presence of manufacturer’s technical representative. Fasteners and types shall be determined by the manufacturer’s technical representative prior to the start of construction to determine pull-out resistance and appropriate fastener type. Based on pull-out test results the frequency of the
fasteners may be required to be increased to meet the manufacturer’s requirements and shall be part of the Base Bid.

E. Do not begin roofing work until all decks, walls, curbs, nailers, accessories, and underlying substrates are ready and acceptable to have roofing materials installed. By beginning roofing work the Contractor acknowledges that such preparatory work is satisfactory.

3.4 MECHANICALLY ATTACHED ROOFING INSTALLATION

A. Compare Manufacturer’s written instructions to those of the Contract Documents. Notify Architect immediately with any contradictions. Contractor to proceed with Work only after approval by Architect.

B. Start installation of roofing membrane in presence of roofing system manufacturer's technical personnel.

C. Attach membrane with fasteners along the edge of the membrane on the fastening line according to manufacturer’s and ASCE-7 wind uplift requirements, for field, perimeter and corners. Fully adhere and mechanically attach base flashings and wall flashings. Fasteners shall penetrate concrete blocks, wood and steel decking (top flutes) 1-1/4 inch minimum or as required by the manufacturer. Fasteners shall be installed using the fastener manufacturer’s recommended torque-sensitive fastening tools with depth locators.

D. Tack welding of membrane of full or half-width rolls for purposes of temporary restraint during installation on windy days is not permitted.

E. Apply membrane roofing with laps shingled with slope of roof deck without laps bucking water.

F. Clean seam areas, overlap membrane roofing, and hot-air weld side and end laps of membrane roofing and sheet flashings according to manufacturer's written instructions to ensure a watertight seam installation.

1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of sheet.
2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.
3. Repair tears, voids, and lapped seams in roofing that do not comply with requirements

G. Around all perimeters and at the base of walls, fasteners and plates shall be installed according to manufacturer’s and ASCE-7 perimeter rate of attachment for the specified wind uplift.
3.5 BASE FLASHING INSTALLATION

A. All flashings shall be installed concurrently with the roof membrane as the job progresses. Flashings shall be installed in order to maintain a watertight condition as the work progresses.

B. No temporary flashings shall be allowed without the prior written approval of the Architect and manufacturer. Approval shall only be for specific locations on specific dates. If any water is allowed to enter under roofing, the affected area shall be removed and replaced at no additional cost to Stanford University. Flashing shall be adhered to compatible, dry, smooth, and solvent-resistant surfaces. Use caution and preventative measures to ensure adhesive fumes are not drawn into the building.

C. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

D. Flash penetrations and field-formed inside and outside corners with membrane flashing. All interior and exterior corners and miters shall be cut and hot-air welded into place. Penetration flashing shall be field fabricated tight to penetration.

E. Install termination bar on the vertical base of parapets, walls and curbs.

F. Apply bonding adhesive per manufacturer’s instructions. Adhesive shall be applied in smooth, even coats with no gaps, globs or similar inconsistencies. Do not apply to seam area of flashing.

G. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

H. Flashings shall extend a minimum of 8 inches above roofing level to first penetration.

Note to Specifier: Coordinate paragraphs below with drawings.

I. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.
   1. Coordinate flashing with counterflashing installation.

J. Terminate and seal top of sheet flashings at penetrations passing through the membrane; anchor at top with a wormgear clamp.
   1. Coordinate flashing with umbrella installation.

3.6 HOT-AIR WELDING
A. All seams shall be hot-air welded. Seam overlaps should be 5-1/2 inch to 7 inches wide (depending upon the type of fastener used) when automatic machine welding and 4 inches wide when hand-welding except for certain details.

B. Welding equipment shall be provided by or approved by TPO membrane manufacturer. All mechanics intending to use the equipment shall have successfully completed a training course provided by a membrane manufacturer’s Technical Representative prior to welding.

C. All membrane to be welded shall be clean and dry.

D. Hand-welded seams shall be completed in three stages. Hot-air welding equipment shall be allowed to warm up for at least one minute prior to welding.
   1. The lap shall be tack welded every 3 ft. to hold the seam in place.
   2. The back edge of the lap shall be welded with a thin, continuous weld to prevent loss of hot air during the final welding.
   3. The hot air nozzle shall be inserted into the lap, keeping the welding equipment at a 45 degree angle to the side lap. Once the proper welding temperature has been reached and the material starts to flow, the hand roller shall be applied at a right angle to the welding gun and pressed lightly. For straight laps, the 1-1/2 in. wide nozzle shall be used. For corners and compound connections, the 3/4 in. wide nozzle shall be used.

E. Machine welded seams are achieved by the use of manufacturer’s automatic welding equipment. When using this equipment, manufacturer’s published instructions shall be followed.

F. Correct welds display failure from shearing of the membrane prior to separation of the weld.
   1. Minimum passing weld, machine weld: 1 inch wide.

3.7 QUALITY CONTROL OF WELDED SEAMS

A. Check all welded seams for continuity using a rounded screwdriver.

B. On-site evaluation of welded seams shall be made daily by Contractor at locations as directed by the Architect, Stanford University or manufacturer’s representative.

C. Inspect membrane seams that are to be covered with rounded screwdriver and re-weld any inconsistencies prior to being covered. Roofing to be covered shall be reviewed and approved by the Architect and manufacturer prior to the installation of the walkway pad.

Note to Specifier: Revise number of seam tests in first subparagraph below to suit
D. A minimum of two inch wide cross-section samples of welded seams shall be taken at least three times a day. Tack weld sample at patch location for observation by Architect.

E. Correct welds display failure from cohesive shearing of the membrane prior to separation of the weld.

F. The Architect may take seam cut test samples randomly during application. Fully cooperate and repair test samples and identified deficiencies promptly.

G. Each test cut shall be patched watertight at no extra cost to Stanford University.

3.8 MEMBRANE CLAD EDGE METAL FLASHING INSTALLATION

A. Space adjacent sheets of membrane clad metal flashing 1/4 inch apart. Cover joint with 2 inch wide aluminum tape centered over joint. Hot-air weld a minimum 4 inch wide strip of flashing membrane over the taped joint.

B. Fasten cleat 8 inches on center. Attach edge metal to 20 gauge galvanized sheet metal continuous cleat.

C. Extend face of edge metal 4 inches minimum below roof deck and 4 inches minimum onto horizontal roofing surface.

D. Fasten edge metal 3 inches on center staggered with ring-shank nails.

E. Hem edges in contact with membrane.

3.9 SHEET METAL INSTALLATION

A. Metal details, fabrication practices and installation methods shall conform to the applicable requirements of the following:
1. ANSI/SPRI ES-1.
2. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) - latest issue.

B. Complete all metal work in conjunction with roofing and flashings so that a watertight condition exists daily.
1. Metal shall be installed to provide adequate resistance to bending to allow for normal thermal expansion and contraction.
2. Metal joints shall be watertight.
3. Metal flashings shall be securely fastened into solid wood blocking. Fasteners shall penetrate the wood a minimum of 1-1/4 inch.
4. Airtight and continuous metal hook strips are required behind metal fascias. Hook strips are to be fastened 12 inches on center into the wood nailer or masonry wall.
5. Counter flashings shall overlap base flashings at least 4 inches.
6. Hook strips shall extend past wood nailers over wall surfaces by 1-1/2 inch minimums and shall be securely sealed from air entry.

3.10 SEALANT APPLICATION

A. Preparation:
1. Remove any existing materials or debris from joint between surfaces. Removal shall be completed with approved equipment.
2. Immediately before sealant installation, clean all surfaces. The surface shall be cleaned to provide uncontaminated, dry surfaces suitable for the application of the new sealant.
3. Clean all joints and surfaces removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt, old sealant.

B. Application:
1. Install joint filler and backers rods where indicated and as necessary.
2. Apply primer as required for substrate type and condition.
3. Apply in continuous beads.
4. Tool immediately, as required, and in a manner to slope water away from sealed surfaces.
5. There shall be no voids across the entire sealant joint cross section.
6. Install backer rod for any joint width 1/4 inch and greater.

3.11 WALKWAY PAD INSTALLATION

A. Install walkway pads in accordance with manufacturer’s written instructions and recommendations. Install where indicated on the Contract Drawings

B. Roofing membrane to receive walkway pads shall be clean and dry.

C. Place chalk lines on deck sheet to indicate location of walkway pads.

D. Inspect all existing deck membrane seams that are to be covered by walkway pads with rounded screwdriver and re-weld any inconsistencies before walkway pad installation. Area to receive walkway pads shall be reviewed and approved by the Architect and manufacturer prior to the installation of the walkway pad.

E. Provide 2-inch gap between walkway pads and between walkway and roof mounted items.

3.12 MISCELLANEOUS MATERIALS

A. Protection Layer: Install additional layer of TPO roofing membrane fully welded on all sides over completed membrane in accordance with membrane manufacturer’s recommendations in all areas where sleepers, pipe supports,
pavers or similar are to be installed on the roof membrane.

B. Pipe Supports: Install pipe supports where indicated and where necessary to support piping. Secure piping to pipe support in accordance with manufacturer’s published instructions and recommendations.

3.13 TEMPORARY CUT-OFF

A. All temporary waterstops shall be constructed to provide a 100 percent watertight seal.

B. The waterstop shall be sealed so that water does not travel under roofing. The edge of the membrane shall be sealed in a continuous heavy application of manufacturer approved sealant.

C. If inclement weather occurs while a temporary waterstop is in place, provide the labor necessary to monitor the situation to maintain a watertight condition.

D. When work resumes, the contaminated membrane shall neatly be cut out in a straight line. All sealant, contaminated membrane, insulation fillers and other components of waterstop shall be removed from the work area and properly disposed of off-site. None of these materials shall be used in the new Work.

E. If any water is allowed to enter under roofing, the affected area and any materials damaged by the water shall be removed and replaced at the Contractor’s expense.

3.14 PERMANENT CUT-OFF

A. Tie into existing roofing per NRCA and manufacturer’s recommendations to ensure a watertight system.

3.15 REPAIRS

A. Repair or remove and replace components of roofing system where test results or inspections indicate that they do not comply with requirements of the Contract Documents. Repairs and additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional Work with specified requirements.

B. Repair or replace components of roofing system and other surfaces damaged or defaced due to the Work of this Project. Repair landscaped areas and adjacent construction damaged by construction activities. Repairs shall be at no additional cost to Stanford University. Repairs shall comply with Contract Documents and written requirements and recommendations of manufacturers of components and surfaces.
C. Repairs of adjacent construction, landscaped areas and other surfaces not part of the scope of the Project shall be repaired to their original condition.

3.16 CLEANING

A. Remove and dispose of roofing debris on a daily basis. Protect all newly installed roof surfaces.

B. Clean all contaminants generated by roofing work from building and surrounding areas, including, but not limited to, adhesives, sealants and coatings.

C. Contractor is responsible for the cleaning and removal of all debris or residue that is tracked from existing roof areas to the installed Thermoplastic membrane.

D. Prior to final inspection, Contractor shall expose and clean the roof membrane to permit inspection of all seams.

E. Prior to Substantial Completion, Contractor shall completely clean the roof membrane so roofing is clean and free of mud, stains and debris at date of Substantial Completion.

3.17 CLOSEOUT ACTIVITIES

A. Final Roof Membrane Inspection: Arrange for roofing system manufacturer’s technical personnel to inspect roofing installation on completion and submit report to Architect.
   1. Notify Architect and Stanford University 48 hours in advance of date and time of inspection.
   2. Substantial Completion: A “no-defect” final roof membrane inspection report is required prior to the Contractor requesting the Substantial Completion review.
   3. Obtain Roofing Manufactures Warranty documents.
   4. Obtain Roofing Installers Warranty documents.

3.18 PROTECTION

A. Where construction traffic must continue over finished roof membrane, provide durable protection and replace or repair damaged roofing to original condition at no additional cost to Stanford University.

B. Protect construction, adjacent construction, adjacent landscaped areas and other areas that might get damaged by the Work.

3.19 FIELD QUALITY CONTROL

A. Testing Agency: Stanford University shall engage a qualified third party testing
agency to perform tests and inspections.

B. Repair or remove and replace components of membrane roofing system where inspections indicate that they do not comply with requirements of the Contract Documents at no additional cost to Stanford University.

END OF SECTION