

CONSTRUCTION STANDARD SPECIFICATION

SECTION 07533

SINGLE PLY ROOFING SYSTEM
THERMAL PROPYLENE OLEFIN (TPO)

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PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections.
- B. Related Sections include the following:
 - 1. Section 07600 Flashing and Sheet Metal
 - 2. Section 13100 Lightning Protection
 - 3. Section 15401 Plumbing, for roof drains

1.02 DESCRIPTION OF WORK

- A. This section includes all material, labor, equipment, temporary protection and tools for the proper installation and completion of the work as required in this specification.
- B. The following items are specified in this section:
 - 1. Roof Insulation
 - 2. Fasteners
 - 3. Roof membrane
 - 4. Roof membrane flashings
 - 5. Treated Wood
 - 6. Sealants
 - 7. Adhesives

1.03 REFERENCES

- A. American Society of Testing and Materials (ASTM)
 - A653 Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality
 - D413 Test Methods for Rubber Property-Adhesion of Flexible Substrate
 - D573 Test Method for Rubber-Deterioration in an Air Oven
 - D751 Test Methods for Coated Fabrics
 - D1149 Test Method for Rubber Deterioration-Surface Ozone Cracking in a Chamber
 - D1203 Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods
 - D1204 Test Method for Linear Dimensional Changes of Nonrigid Thermoplastic Sheeting or Film at Elevated Temperature
 - D2136 Test Method for Coated Fabrics-Low Temperature Bend Test
 - D2240 Test Method for Rubber Property-Durometer Hardness
 - E84 Test Method for Surface Burning Characteristics of Building Materials
 - E408 Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
 - E838 Practice for Performing Accelerated Outdoor Weathering Using Concentrated Natural Sunlight
 - E903 Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres
- B. California South Coast Air Quality Management District (AQMD)
 - Rule 1168 Adhesive and Sealant Applications
- C. California Bay Area Air Quality Management District (AQMD)
 - Regulation 8 Rule 51, Organic Compounds Adhesive and Sealant Products
- D. Factory Mutual (FM)
 - Approval Guide
 - Approval Standard No. 4470 Class 1 Roof Covers
- E. Federal Specification (FS)
 - HH-I-1972/2 Class 1 Insulation Board, Thermal Polyurethane or Polyisocyanurate, Faced with Asphalt/Glass Fiber Felt on Both Sides of the Foam

- F. Federal Test Method (FTM)
FTM 101B Method 2031 Puncture Resistance
- G. National Roofing Contractors Association (NRCA)
Roofing and Waterproofing Manual
- H. Underwriter's Laboratories, Inc. (UL)
Roofing Materials and Systems Directory

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's technical product data, installation instructions and recommendations for each type of roofing product required. Include data substantiating that materials comply with the specified requirements.
- B. Submit copy of the membrane manufacturer's warranty covering materials.
- C. Submit copy of the Roofing Contractor's warranty covering workmanship.
- D. Submit dimensioned shop drawings, which shall include:
 - 1. An outline of the roof and roof size.
 - 2. Proposed installation method for insulation and membrane for each different section of roof. Include insulation type (e.g. flat, tapered) and fastener patterns if applicable. Show Contractor's proposed method of achieving specified roof slopes.
 - 3. Proposed profile details of flashing methods for penetrations and terminations if not indicated in the Contract Documents.
 - 4. Proposed location of manufacturer approved walkpads. Corners are to be rounded and installed in accordance with manufacturer's written instructions. All side and end joints shall be hot-air welded a minimum of 2"-inch (51mm). No adhesive shall be present within the lap areas.
- E. Submit report from an independent testing laboratory certifying that manufacturer's membrane has met a minimum of 2,000,000 langley's concentrated natural sunlight, according to ASTM E838.
- F. Submit written documentation from the manufacturer that the proposed roofing system including insulation and fasteners are compatible and meet the applicable requirements and code approvals as referenced in this specification and that the roofing system meets the requirements for the manufacturers standard warranty covering material.
- G. Submit certification that membrane installer is a manufacturer-approved applicator.
- H. Submit manufacturer's documentation of Energy Star labeled roofing materials.

- I. Submit Material Safety Data Sheets (MSDS) and manufacturer's documentation of Volatile Organic Compound (VOC) content for each adhesive and sealant product.
- J. Submit manufacturer's documentation of recycled content for Polyisocyanurate insulation.

1.05 QUALITY ASSURANCE

- A. Roofing system shall be applied only by an approved Contractor authorized prior to bid by the roof membrane manufacturer. Prior to bid, the Roofing Contractor must have completed a minimum of 500 roofing squares of Thermal Propylene Olefin (TPO) membrane in the Southwest.
- B. There shall be no deviation from this specification or the approved shop drawings without prior written approval by the manufacturer and the Sandia Delegated Representative (SDR).
- C. Code Requirements: The proposed roofing system shall meet the requirements of the following recognized code approval or testing agencies. These requirements are the minimum standards and no roofing work shall commence without written documentation of the system's compliance, as in Article 1.03 "Submittals".
 - 1. Underwriters Laboratories (UL) Class A membrane.
 - 2. Factory Mutual (FM) I-90 uplift rating, per FM Approval Standard No. 4470.
- D. Energy Star Roof Compliance: The proposed roofing system shall be Energy Star Roof-compliant and roofing materials shall be Energy Star labeled.
- E. For new installations, ponding shall not occur in accordance with NRCA Roofing and Waterproofing manual good roof design practice, which dictates that there be no ponding of water 48 hours after rainfall.
- F. There shall be no more than 20 patches per 10,000sf on new construction.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. All products delivered to the job site shall be in the original unopened container or wrappings.
- B. Membrane rolls and insulation shall be stored fully protected from moisture and wind damage. Remove plastic from insulation and cover with tarpaulins on a raised surface.
- C. Bonding adhesives shall be stored at temperatures recommended by manufacturer.
- D. Handle all materials to prevent damage. Any materials which are determined damaged, according to the SDR, are to be removed from the job site and replaced at no cost to Sandia National Laboratories (SNL).

1.07 PROJECT CONDITIONS

- A. Construction may not be fully represented on the drawings, and some modifications to details may be required to accomplish the intent of the documents.
 - 1. Contractor shall ascertain to his satisfaction, coordinate with General Contractor and other sub-contractors prior to bidding, that the specifications and drawings are workable and that they are not in conflict with the manufacturer's requirements for a material warranty.
- B. 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, and any damages shall be repaired or replaced at no cost to SNL. All exterior lighting, equipment, landscaping and paving shall be protected from damage.
- C. Contractor shall test drains per SDR's direction prior to and upon completion of roofing work to insure that no blockage exists or has occurred.
- D. Only as much of the new roofing as can be made weather tight each day including all flashing work, shall be installed. Plug all roof drains before starting work each day and unplug all drains at the end of each workday.
- E. All surfaces to receive insulation, membrane or flashing shall be thoroughly clean and dry. Should surface moisture occur, the Contractor shall provide the necessary equipment and labor to dry the surface prior to application.
- F. All construction, including equipment and accessories, shall be secured against wind blow-off damage.
- G. Temporary waterstops shall be installed at the end of each day's work and shall be removed before proceeding with the next day's work. Waterstops shall be compatible with all materials, shall not emit dangerous or incompatible fumes, and shall be installed per manufacturer's recommendations.
- H. Contractor shall provide all necessary protection and barriers to segregate the work area and to prevent damage to adjacent areas. Plywood protection shall be provided for all new and existing roof areas which receive traffic during construction.
- I. Contaminants, such as grease, fats, oils and solvents shall not be allowed to come into direct contact with the roofing membrane. Any exposures shall be presented to the membrane manufacturer for assessment of impact on the roof system performance.
- J. Contractor shall take care during application and storage that overloading of deck and structure does not occur.
- K. Precautions shall be taken when using adhesives at or near rooftop vents or air intakes. Coordinate closing or shut-offs of vents and air intakes during roofing and flashing operations.

1.08 WARRANTY

- A. Upon completion of construction, the manufacturer's ten (10) year warranty covering materials shall be issued to SNL.
- B. Roofing Contractor shall supply SNL with a minimum two (2) year workmanship warranty. In the event any work related to roofing, flashings, or metal work is found to be defective or otherwise not in accordance with the Contract Documents within two (2) years of final acceptance, the roofing Contractor shall remove and replace the defects at no cost to SNL.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Provide an insulated roofing system that is comprised of fully compatible components for use in the proposed application. All proposed materials shall be compatible with substrate.

2.02 MEMBRANE

- A. TPO: Polyester scrim reinforced Thermal Propylene Olefin (TPO) sheet conforming to the following minimum physical properties:

<u>Property</u>	<u>ASTM Test Method</u>	<u>Specification</u>
Color		White
Weight	D751	0.18 lbs/sq ft (0.88 kg/m ²)
Nominal Thickness (min.)	D751	0.060"-inch (1.52 mm)
Breaking Strength (min.)	D751 (Grab Method)	225 lbf (1.0 kN)
Tear Strength (min.)	D751 (Tongue Tear)	55 lbf (245 N)
Low Temperature Bend	D2136	Pass
Shore A Hardness	D2240	80 \pm 5
Heat Aging	D573	Maintains original strength
Volatility, Max. Loss	D1203, Method A	0.5 %
Hydrostatic Resistance (min.)	D751, Method A	300 psi (2.1 Mpa)
Ozone Resistance	D1149	No Effect
Emmaqua Concentrated Natural Sunlight, 2 million langleys	E838	No visible surface cracking or stiffening
Dimensional Stability (max.)	D1204	0.5 %
Puncture Resistance (min.)	FTM 101B, Method 2031	250 lbf (1.1 kN)
180 degrees Peel Strength (min.)	D413	35 lbf (156 N)
Change in Weight After Immersion in Water (max.)	D570	+3.0%
Initial solar Reflectance (min.)	E903	0.65
3-year aged Solar Reflectance (min.)	E903	0.50
Emissivity (min.)	E408	0.90

2.03 FLASHING MEMBRANE

- A. Flashing membrane shall be as supplied by the roofing membrane manufacturer. Flashing membranes are generally the same material as the roofing membrane unless otherwise specified in the Contract Documents. Unreinforced 0.055"-inch (1.4 mm) thick ethylene propylene - base membrane shall be supplied for vent stacks, pipes, drains and corners.

2.04 INSULATION

- A. General: Provide insulating materials to comply with referenced standards and requirements indicated for materials; provide manufacturer's standard thickness, in size to fit applications.
 - 1. Fully Adhered Systems: Provide no greater than 4'-feet x 4'-feet (1.2m x 1.2m) boards.
 - 2. Mechanically Fastened Systems: Provide 4'-feet x 8'-feet (1.2m x 2.4m) boards.
- B. Polyisocyanurate Board Roof Insulation: Furnish and install rigid, cellular thermal insulation with Polyisocyanurate closed-cell foam core and manufacturer's standard facing laminated to both sides to comply with FS HH-I-1972/2 Class 1. Provide in two (2) layers for a total thickness to meet an average R-value of 30.0, unless indicated elsewhere on the Contract Documents.
 - 1. Surface Burning Characteristics: Comply with ASTM E84 with a maximum flame spread and smoke developed values of 25 and 145, respectively.
 - 2. Recycled Content: Minimum 9 percent.
- C. Insulation, fasteners and adhesive shall be supplied or approved by the roof membrane manufacturer for compatibility with the system and the required FM and UL requirements. Adhesives shall comply with VOC limits of California South Coast (AQMD) Rule #1168.
- D. Recovery Board: Provide one half-inch (1/2"-inch, 13mm) Dens Deck, or approved equal, over all insulation and tapered insulation.

2.05 ACCESSORY PRODUCTS

- A. Flashing Adhesive: As specified by the membrane manufacturer to comply with VOC limits of California South Coast (AQMD) Rule #1168. Any adhesives containing carcinogens shall be limited to vertical surfaces and flashings.
- B. Walkway Membrane: Membrane manufacturer's walkway material.
- C. Wood Nailers: Wood shall be #2 or better pressure preservative treated lumber using CCA preservatives. Height of nailers shall match that of the insulation thickness or as indicated on the drawings.
- D. Sealants: As recommended by the membrane manufacturer to comply with VOC limits of California Bay Area (AQMD) Regulation 8, Rule 51.

- E. Miscellaneous Fasteners and Anchors: In general, all fasteners, anchors, nails and straps shall be of zinc-coated steel, galvanized, or stainless steel and cadmium-free. All fasteners and anchors shall have a minimum embedment of 1-1/2"-inch (38 mm) and shall be approved for such use by the fastener manufacturer and the membrane manufacturer.
- F. Sheet Metal Accessory Materials: ASTM A653, with 0.20 percent copper, G90 hot-dipped galvanized, 24-gauge (0.61 mm) or heavier.
- G. Expansion Joint Covers: Shall be the manufacturer's prefabricated units of the same material as the roof membrane.
- H. Perimeter Edge Metal: Shall be supplied by the membrane manufacturer and coated with the same material as the roofing membrane and shall be compatible with the roofing membrane for hot-air welding.
- I. Slip Sheet: Provide only when needed between incompatible materials. Use membrane manufacturers standard slip-sheet material.
- J. Base Sheet: Provide membrane manufacturers recommended vented base sheet on all types of concrete decks or when required or recommended by membrane manufacturer for the intended application.
- K. B-Line Rooftop Supports or approved equal. To be placed at a minimum of 10'-feet (3m) on center for proper support. Refer to SNL Standard Detail Drawing for rooftop supports, AE5035 and AE5036.

PART 3 - EXECUTION

3.01 INSPECTION

- A. Prior to all work of this section, Contractor shall carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence.
- B. Verify that work of other trades that penetrate the roof deck has been completed.
- C. Verify that roofing system may be installed in strict accordance with all pertinent codes and regulations, the original design and the manufacturer's recommendations.
- D. In the event of discrepancy, immediately notify the SDR.
- E. Do not proceed with installation in areas of discrepancy until all such discrepancies have been fully resolved.
- F. Upon starting the installation of a new roof, the SDR and the General Contractor and their sub-contractor, if applicable, will designate a portion of the installation to be used as a mock up. This area will be the model of how the roof installation shall be installed. The mock up should include the insulation, a curb, flashing, parapet and an inside and outside corner along with a termination and lap seam.

- G. Throughout the project and at completion, the SDR shall be allowed to inspect the roof, including probing as necessary to ensure proper installation.

3.02 PREPARATION OF SUBSTRATE

- A. General: Comply with the insulation and membrane manufacturer's instructions for preparation of the substrate to receive the roofing system.
- B. Clean substrate of dust, debris, and other substances detrimental to the system work. Remove sharp projections.
- C. Notify the SDR to inspect the substrate. Contractor shall not proceed with installation until the SDR has approved the substrate.

3.03 INSTALLATION OF INSULATION

- A. Insulation shall be installed according to the insulation manufacturer's instructions and shall be approved by the SDR and membrane manufacturer. Stagger joints between layers.
- B. Insulation shall be neatly cut to fit around all penetrations and projections.
- C. Install tapered insulation where applicable in accordance with insulation manufacturer's approved shop drawings in order to achieve the specified slope.
- D. Install tapered insulation around drains creating a drain sump.
- E. Do not install more insulation board than can be covered with membrane by the end of the day, or onset of inclement weather.
- F. Attachment
 - 1. Insulation shall be mechanically fastened to the deck with approved fasteners and plates at a rate and pattern acceptable to Factory Mutual's and membrane manufacturer's requirements for fastening rates and patterns.
 - 2. Fasteners are to be installed in accordance with the fastener manufacturer's recommendations. Fasteners are to have a minimum penetration into the structural deck as recommended by the fastener manufacturer and membrane manufacturer. Fasten only in top of ribs of metal deck, not flutes.
 - 3. Perform pull out tests for the SDR to verify deck conditions and actual pull out values prior to installation of the membrane.
 - 4. Use fastener tools with a depth locator as recommended or supplied by the fastener manufacturer to ensure proper installation.

3.04 INSTALLATION OF MEMBRANE

- A. Install materials in accordance with manufacturers instructions for the intended application.

- B. Surface of the insulation shall be inspected prior to installation of the roof membrane. The insulation surface shall be clean and smooth with no excessive surface roughness, contaminated surfaces, or unsound surfaces such as broken or delaminated insulation boards.
- C. Membrane shall be installed per the membrane manufacturer's written installation procedures for an approved mechanically fastened system.
- D. No bonding adhesive shall be applied to lap areas that are to be welded to flashing or adjacent sheets. All sheets shall be applied in the same manner, lapping all sheets as required by welding techniques. No peel and stick products allowed.
- E. Any repairs or patches shall be hot-air welded. No peel and stick products allowed.
- F. Adjacent sheets shall be welded in accordance with the manufacturer's written instructions.
- G. Hand and machine welding shall be carried out per the manufacturer's written instructions. All mechanics intending to use the welding equipment shall have successfully completed a course of instruction provided by a manufacturer's representative prior to welding. All welding equipment must be approved by the manufacturer prior to use.
- H. All completed seams shall be checked by the Contractor after cooling for continuity using a screwdriver or suitable blunt instrument. In addition, on-site evaluation of welded seams shall be made by Contractor at locations as directed by the SDR or membrane manufacturer's representative. Contractor shall provide 2"-inch (51 mm) wide cross-sectional samples taken through completed seams. Approximately two samples will be taken per 100 roofing squares. Correctly welded seams display failure from shearing of the membrane prior to separation of the weld. Each test cut shall be patched by the Contractor at no additional charge to SNL.
- I. Exposed or cured membrane shall be hot-air welded per manufacturer's instructions.
- J. During the course of the work, the entire roof area shall be kept clear of loose or spilled fasteners and metal scraps to guard against accidental puncture of the membrane.

3.05 MEMBRANE FLASHINGS

- A. All flashing shall be installed concurrently with the roof membrane as the job progresses. No temporary membrane flashings shall be allowed without the prior written approval of the SDR. Approval shall only be for specific locations on specific dates.
- B. All flashing membranes shall be fully adhered to substrates. All interior and exterior corners and miters shall be cut and hot-air welded in place, or prefabricated corners and miters may be used.

1. Bituminous elements shall not be in contact with non-compatible membrane. Manufacturers recommended isolator shall be used to isolate non-compatible membrane flashing from bituminous coated elements such as vent stacks and pipes penetrating the roof.
- C. All flashings shall be hot-air welded at their joints and at their connections with the roof membrane. No peel and stick products allowed.
 - D. Pipe penetrations shall be flashed a minimum of 8"-inches (203 mm) above the roofing membrane, and terminate with a stainless steel hose clamp with sealant applied along the top edge. Pipe should be isolated by membrane. Factory fabricated pipe seals and roof membrane shall be welded as outlined. A buffer layer of membrane shall be installed between hose clamp and flashing sheet to avoid damage.
 - E. All curb flashing membranes shall be mechanically fastened along the top using nails with 1"-inch (25 mm) diameter heads spaced a maximum of 6"-inches (152 mm) on center, or predrilled metal strips. All roof edge flashings shall be hot-air welded to the membrane manufacturer's coated metal. Predrilled metal strips shall be caulked along the top edge with a sealant. Expansion pins with nylon sheaths set in predrilled holes shall be used to secure flashings to masonry and concrete surfaces. Reglets shall be used on walls as shown on the Contract Documents.
 - F. Edge metal shall be supplied by the membrane manufacturer and shall be coated with the same material as the roofing membrane. The edge metal and membrane strips joining each piece of edge metal shall closely match the color of the building perimeter, unless specified elsewhere on the Contract Documents or by the SDR.

3.06 TEMPORARY CUT-OFF

- A. Flashings shall be installed concurrently with the roof membrane in order to maintain a watertight condition as the work progresses. When a break in the day's work occurs in the central area of the roof, a temporary waterstop shall be constructed to provide a watertight seal.
 1. Waterstop shall be installed per the manufacturer's recommendations and per details shown on the Contract Documents.
 2. When work on the new system is suspended, the stagger of the insulation joints shall be maintained by installing partial fillers. New membrane shall be carried into the waterstop.
 3. When work resumes, the contaminated membrane, insulation fillers, etc., shall be removed from the work area and disposed off-site. Do not reuse these materials in new work.
- B. If inclement weather occurs while a temporary waterstop is in place, the Contractor shall provide the labor necessary to monitor the situation to maintain a watertight condition.

3.07 WALKWAY INSTALLATION

Walkways: Install walkway pads at location shown on Construction Documents. Hot-air weld along edges a minimum of 2"-inches (51mm) to substrate, and fully adhere walkway pads between welds to substrate with compatible adhesive according to roofing system manufacturer's written instruction. Corners of walkway are to be rounded and hot-air welded in accordance with manufacturer's written instruction.

3.08 COMPLETION

- A. At the completion of construction and prior to Contractor's request for final inspection by SDR, membrane manufacturer's technical consultant shall provide on-site inspection of installed roofing system.
 - 1. Membrane manufacturer shall provide Contractor and SDR with itemized list of defects or non-compliance with manufacturer's recommendations.
 - 2. Contractor shall immediately correct identified items. Complete corrections before request for final inspection from SDR.
- B. Prior to demobilization from site, work shall be reviewed by SDR and Contractor.
 - 1. Itemize defects or non-compliance with these specifications or membrane manufacturer's recommendations in punch list.
 - 2. Contractor shall immediately correct identified items prior to demobilization, to satisfaction of SDR and membrane manufacturer.
- C. Upon completion of construction, the Contractor shall install a metal sign (minimum size of 8" x 10", or 203mm x 254mm) at each roof entryway providing the following information:
 - 1. Contractor Company Name
 - 2. Membrane Manufacturer
 - 3. SNL Inspector Name
 - 4. Date of Installation

END OF SECTION