

Specification Section 07533 Single Ply Roofing System - (TPO)

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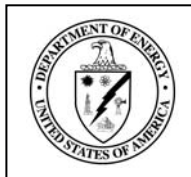


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Part 1 - General

1.01 Summary

- 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

1.02 References

The current editions of the following standards are a part of this specification:

- A. Drawing and general provision of the contract, including General and Supplementary Conditions and Division 1 specification sections.
- B. SNL Construction Standard Specifications and Drawings

Number	Title
	Drawings and general provision of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections.
Section 07600	Flashing and Sheet Metal
Section 13100	Lightning Protection
Section 15401	Plumbing For Roof Drains

- C. American Society of Testing and Materials (ASTM)

Number	Title
A653	Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc Iron Alloy Coated (Galvannealed) by the Hot-Dip Process
D413	Test Methods for Rubber Property--Adhesion of Flexible Substrate
D573	Standard Test Methods for Rubber--Deterioration in an Air Oven
D751	Test Methods for Coated Fabrics
D1149	Standard Test Methods for Rubber Deterioration Cracking in an Ozone Controlled

Number	Title
	Environment
D1203	Standard Test Methods for Volatile Loss from Plastics Using Activated Carbon Methods
D1204	Standard 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	Standard Test Method for Surface Burning Characteristics of Building Materials
E108	Standard Test Method for Fire Test of Roof Coverings
E408	Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques
E903	Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres (Withdrawn 2005)
E1980-11	Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low Sloped Opaque Surfaces
G90-10	Standard Practice for Performing Accelerated Outdoor Weathering of Nonmetallic Materials Using Concentrated Natural Sunlight

D. California South Coast Air Quality Management District (AQMD)

- Rule 1168 Adhesive and Sealant Applications

E. California Bay Area Air Quality Management District (AQMD)

- Regulation 8, Rule 51, Organic Compounds Adhesive and Sealant Products

F. Factory Mutual Global® (FM)

- Approval Guide
- Approval Standard No. 4470, Class 1 Roof Covers

G. 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

H. Federal Test Method (FTM)

- FTM 101b Method 2031, Puncture Resistance

I. National Roofing Contractors Association (NRCA)

- Roofing and Waterproofing Manual

J. Underwriters Laboratories, Inc. (UL®)

- Roofing Materials and Systems Directory

1.03 Submittals

- A. Product Data: Submit manufacturer 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 warranty covering materials.
- C. Submit copy of the Roofing Contractor warranty covering workmanship.
- D. Submit dimensioned shop drawings, which include the following:
 - 1. An outline of the roof and roof size.
 - 2. The proposed installation method for insulation and membrane for each different section of roof. Include insulation type (flat, tapered) and fastener patterns, if applicable. Show Contractor's proposed method of achieving specified roof slopes.
 - 3. The proposed profile details of flashing methods for penetrations and terminations, if not indicated in the Contract Documents.
 - 4. The proposed location of manufacturer-approved walkpads. Walkway corners must be rounded and welded in accordance with the manufacturer written instructions. All side and end joints must be hat-air welded a minimum of 2 inches (51mm). Adhesive cannot be present within lap areas.
- E. Submit report from an independent testing laboratory certifying that manufacturer membrane has met a minimum of 2,000,000 langleys concentrated natural sunlight, according to ASTM E838.
- F. Submit written documentation from the manufacturer that the proposed roofing system, including insulation and fasteners, is compatible and meets 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 from the membrane manufacturer a list of Contractor personnel who have been trained successfully to perform membrane welding and who will be working on this project. The membrane manufacturer must also submit approval of the Contractor's welding equipment.
- H. Submit manufacturer documentation of ENERGY STAR® labeled roofing materials.
- I. Submit Material Safety Data Sheets (MSDS) and manufacturer documentation of volatile organic compound (VOC) content for each adhesive and sealant product.
- J. Submit manufacturer documentation of recycled content for polyisocyanurate insulation.
- K. Preliminary Roofing Submittal Conference
 - 1. Meet with the Architect, SNL Project Lead, SNL Architect, and the SNL Inspector to review the Roofing submittal.
 - a. Confirm manufacturer and proposed roofing manufacturer meets current SNL standards.
 - b. Identify any conflicts, changes, or modifications to the original layout that might modify effect the project.

- c. Discuss any security or safety issues for the building and the impact that may have on the project.
- d. Discuss the importance of proper roofing practices and convey the information to subcontractors involved.
- e. Record all significant conference discussions, agreements, and disagreements, including required corrective measures and actions.

1.04 Quality Assurance

- A. Roofing system must 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 Thermalplastic Olefin (TPO) membrane in the Southwest. To qualify for this requirement, the completed membrane must have met all conditions to obtain material and labor warranty, and must be performing successfully.
- B. There must 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 must meet the requirements of the following recognized code approval or testing agencies. These requirements are the minimum standards and no roofing work will commence without written documentation of the system's compliance, as in section 1.03, *Submittals*.
 - 1. Underwriters Laboratories (UL) Class A membrane
 - 2. Factory Mutual Global® (FM) I-90 uplift rating, per FM Approval Standard No. 4470
- D. ENERGY STAR Roof Compliance: The proposed roofing system must be ENERGY STAR Roof-compliant and roofing materials must be ENERGY STAR labeled.
- E. For new installations, in accordance with NRCA Roofing and Waterproofing annual good roof design practice, there will be no ponding of water 48 hours after rainfall.
- F. No more than 20 patches per 10,000 square feet on new construction.

1.05 Delivery, Storage, and Handling

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

1.06 Project Conditions

- A. Construction might not be fully represented on the drawings, and some modifications to details may be required to accomplish the intent of the documents.
 - Contractor must 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 requirements for a material warranty.
- B. All work must be scheduled and executed without exposing the interior building areas to the effects of inclement weather. The existing building and its contents must be protected against all risks, and any damages must be repaired or replaced at no cost to SNL. All exterior lighting, equipment, landscaping and paving must be protected from damage.
- C. Contractor must test drains per SDR's direction before and after 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 weathertight each day including all flashing work, will 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 must be thoroughly clean and dry. Should surface moisture occur the Contractor must provide the necessary equipment and labor to dry the surface prior to application.
- F. All construction, including equipment and accessories, must be secured against wind blow-off damage.
- G. Temporary waterstops must be installed at the end of each workday and must be removed before proceeding with the next day's work. Waterstops must be compatible with all materials, must not emit dangerous or incompatible fumes, and must be installed per manufacturer recommendations.
- H. Contractor must provide all necessary protection and barriers to segregate the work area and to prevent damage to adjacent areas. Plywood protection must be provided for all new and existing roof areas that receive traffic during construction.
- I. Before and during applications, all dirt, debris, and dust must be removed from surfaces by either sweeping or vacuuming. Compressed-air cleaning is prohibited.
- J. Liquid materials such as solvents and adhesives must be stored and used away from open flames, sparks, and excessive heat.
- K. Membranes and accessories must not be exposed to a temperature exceeding 160°F (71°C) for a prolonged period.
- L. Contaminants such as grease, fats, oils, and solvents must not be allowed to come into direct contact with the roofing membrane. Any exposures must be presented to the membrane manufacturer for assessment of effect on the roof system performance.
- M. Contractor must take care not to overload deck and structure during application and storage.
- N. Clean the site, including both interior and exterior building areas below or adjacent to, or in any way affected by the construction of the roof: Cleaning of the membrane with

gasoline is prohibited. Use only cleaners approved by the roof membrane manufacturer and the SDR to clean the membrane. Notify the SDR before using any solvent or cleaner to allow intake fans to be shut down.

- O. All roofing, insulation, flashings, and metal work removed for construction must be promptly taken off the site to a legal dumping area. Coordinate with SNL Pollutions Prevention (P2) to try to recycle removed material.
- P. Take precautions when using adhesives at or near rooftop vents or air intakes. Coordinate closing or shutting off vents and air intakes during roofing and flashing operations.

1.07 Warranty

- A. On construction completion, the manufacturer will provide a 20-year warranty covering materials must be issued to SNL.
- B. The Roofing Contractor must supply SNL with a minimum 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 2 years of final acceptance, the Roofing Contractor must remove and replace the defects at no cost to SNL.

Part 2 - Products

2.01 General

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

2.02 Membrane

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

Property	ASTM Test Method	Specification
Color		White
Weight	D751	0.18 lbs/sq ft (0.88 kg/m ²)
Nominal Thickness (minimum)	D751	0.060-inch (1.52 mm)
Breaking Strength (minimum)	D751 (Grab Method)	225 lbf (1.0 kN)
Tear Strength (minimum)	D751 (Tongue Tear)	55 lbf (245 N)
Low Temperature Bend	D2136	Pass
Shore A Hardness	D2240	80 +5
Heat Aging	D573	Maintains original strength
Volatility, Maximum Loss	D1203, Method A	0.5 %
Hydrostatic Resistance (minimum)	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 (maximum)	D1204	0.5 %
Puncture Resistance (minimum)	FTM 101B, Method 2031	250 lbf (1.1 kN)
180 degrees Peel Strength (minimum)	D413	35 lbf (156 N)
Change in Weight After Immersion in Water (maximum)	D570	+3.0%
Cool Roof Replacement: 3 year aged Solar Reflectance: 0.55 and 3-year Aged Thermal Emittance: 0.75		
or 3 year aged Solar Reflectance Index (SRI): 64	ASTM Standard E1980-01	
Compliant with ASTM Roof Covering Fire Test	E108 or UL 790	

2.03 Flashing Membrane

Flashing membrane must 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 must 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 standard thickness, in size to fit applications.
1. Fully Adhered Systems: Provide no greater than 4 x 4-foot (1.2m x 1.2m) boards.
 2. Mechanically Fastened Systems: Provide 4 x 8-foot (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 standard facing laminated to both sides to comply with FS HH-I-1972/2 Class 1. Provide in 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 %.
- C. Insulation, fasteners and adhesive** must be supplied or approved by the roof membrane manufacturer for compatibility with the system and the required FM and UL requirements. Adhesives must comply with VOC limits of California South Coast (AQMD) Rule #1168.
- D. Recovery Board:** Provide ½-inch (13mm) DensDeck®, 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 must be limited to vertical surfaces and flashings.
- B. Walkway Membrane:** Membrane manufacturer walkway material.
- C. Wood Nailers:** Wood must be #2 or better pressure preservative treated lumber using non-CCA preservatives. Height of nailers must 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 must be of zinc-coated steel, galvanized or stainless steel, and cadmium-free. All fasteners and anchors must have a minimum embedment of 1½ inch (38 mm) and must be approved for such use by the fastener manufacturer and the membrane manufacturer.

- F. Metal Accessory Materials: ASTM A653, with 0.20% copper, G90 hot-dipped galvanized, 24-gauge (0.61 mm) or heavier.
- G. Expansion Joint Covers: Must be the manufacturer prefabricated units of the same material as the roof membrane.
- H. Perimeter Edge Metal: Must be supplied by the membrane manufacturer and coated with the same material as the roofing membrane and must be compatible with the roofing membrane for hot-air welding.
- I. Slip Sheet: Provide only when needed between incompatible materials. Use membrane manufacturer standard slip-sheet material.
- J. Base Sheet: Provide membrane manufacturer 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 Drawings for rooftop supports, AE5035 and AE5036.

Part 3 - Execution

3.01 Inspection

- A. Prior to all work in this section, Contractor must 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 penetrates the roof deck has been completed.
- C. Verify the roofing system may be installed in strict accordance with all pertinent codes and regulations, the original design, and the manufacturer 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 subcontractor, (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 must 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 must 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 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. Request the SDR inspect the substrate. The Contractor must not proceed with installation until the SDR has approved the substrate.

3.03 Installation of Insulation

- A. Insulation must be installed according to the insulation manufacturer instructions and must be approved by the SDR and membrane manufacturer. Stagger joints between layers.
- B. Insulation must be neatly cut to fit around all penetrations and projections.
- C. Install tapered insulation where applicable in accordance with insulation manufacturer-approved shop drawings 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 must be mechanically fastened to the deck with approved fasteners and plates at a rate and pattern acceptable to FM and membrane manufacturer requirements for fastening rates and patterns.
2. Fasteners must be installed in accordance with the fastener manufacturer recommendations. Fasteners must 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.
5. All joints and seams must fit tightly to prevent gaps, voids, and surface irregularities.

3.04 Installation of Membrane

- A. Install materials in accordance with manufacturer instructions for the intended application.
- B. The surface of the insulation must be inspected prior to installation of the roof membrane. The insulation surface must be clean and smooth with no excessive surface roughness, contaminated surfaces, or unsound surfaces such as broken or delaminated insulation boards.
- C. Membrane must be installed per the membrane manufacturer written installation procedures for an approved, mechanically-fastened system or a fully-adhered system.
- D. No bonding adhesive should be applied to lap areas that are to be welded to flashing or adjacent sheets. All sheets must be applied in the same manner, lapping all sheets as required by welding techniques. No peel-and-stick products are allowed.
- E. Any repairs or patches must be hot-air welded. Peel-and-stick products are not allowed.
- F. Adjacent sheets must be welded in accordance with the manufacturer's written instructions. All side and end lap joints must be hot-air welded. Lap area must be a minimum of 3 inches (76 mm) wide when machine welding, and a minimum of 4 inches (102 mm) wide when hand welding. Adhesive must not be present within the lap areas.
- G. Hand and machine welding must be carried out per the manufacturer written instructions. All mechanics intending to use the welding equipment must have successfully completed a course of instruction provided by a manufacturer representative prior to welding. All welding equipment must be approved by the manufacturer prior to use.
- H. All completed seams must be checked by the Contractor after cooling for continuity using a suitable blunt instrument. In addition, on-site evaluation of welded seams must be made by the Contractor at locations as directed by the SDR or membrane manufacturer representative.
- I. Contractor must provide 2-inch (51 mm) wide cross-sectional samples taken through completed seams. 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 must be patched by the Contractor at no additional charge to SNL.

- J. Exposed or cured membrane must be hot-air welded per manufacturer instructions.
- K. During the course of the work, the entire roof area must 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 must be installed concurrently with the roof membrane as the job progresses. No temporary membrane flashings are allowed without the prior written approval of the SDR. Approval must only be for specific locations on specific dates.
- B. All flashing membranes must be fully adhered to substrates. All interior and exterior corners and miters must be cut and hot-air welded in place, or prefabricated corners and miters may be used.
 - Bituminous elements must not contact noncompatible membrane. Manufacturer- recommended isolator must be used to isolate noncompatible membrane flashing from bituminous coated elements such as vent stacks and pipes penetrating the roof.
- C. All flashings must be hot-air welded at their joints and at their connections with the roof membrane. Peel-and-stick products are not allowed.
- D. Pipe penetrations must 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 must be welded as outlined. A buffer layer of membrane must be installed between hose clamp and flashing sheet to avoid damage.
- E. All curb flashing membranes must 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 must be hot-air welded to the membrane manufacturer coated metal. Predrilled metal strips must be caulked along the top edge with a sealant. Expansion pins with nylon sheaths set in predrilled holes must be used to secure flashings to masonry and concrete surfaces. Reglets must be used on walls as shown on the Contract Documents.
- F. Edge metal must be supplied by the membrane manufacturer and must be coated with the same material as the roofing membrane. The edge metal and membrane strips joining each piece of edge metal must closely match the color of the building perimeter, unless specified elsewhere on the Contract Documents or SNL Architect.

3.06 Temporary Cut-Off

- A. Flashings must 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 must be constructed to provide a watertight seal.
 - 1. Waterstop must be installed per the manufacturer recommendations and details shown on the Contract Documents.

2. When work on the new system is suspended, the stagger of the insulation joints must be maintained by installing partial fillers. New membrane must be carried into the waterstop.
 3. When work resumes, the contaminated membrane, insulation fillers, and such must be removed from the work area and disposed of off-site. Do not reuse these materials in new work.
- B. If inclement weather occurs while a temporary waterstop is in place, the Contractor must 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 written instruction. Corners of walkway are to be rounded and hot-air welded in accordance with manufacturer written instruction.

3.08 Construction Completion

- A. At the completion of construction and prior to Contractor's request for final inspection by SDR, membrane the manufacturer technical consultant must provide onsite inspection of installed roofing system.
1. Membrane manufacturer must provide Contractor and SDR with an itemized list of defects or noncompliance with manufacturer recommendations.
 2. Contractor must immediately correct identified items. Complete corrections before requesting the SDR to perform the final inspection.
- B. Prior to demobilization from site, work must be reviewed by SDR and Contractor.
1. Itemize defects or noncompliance with these specifications or membrane manufacturer recommendations in a punch list.
 2. Contractor must immediately correct identified items prior to demobilization to satisfaction of SDR and membrane manufacturer.
- C. Upon completion of construction, the Contractor must install a metal sign (minimum size of 8 x 10 inch, (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