

**FIRESTONE GARDEN ROOFING SYSTEMS
DESIGN GUIDE**

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1.01 GENERAL

A. DESCRIPTION

1. Firestone Garden Roofing Systems utilize one of the following membranes fully adhered to an approved substrate:
 - RubberGard Platinum membrane
 - RubberGard Non-Reinforced EPDM membrane
 - RubberGard MAX Reinforced EPDM membrane
 - UltraPly TPO membrane
2. The thickness of the membrane is dependant upon the roof garden type and warranty selected. Refer to Section 1.04, of this Design Guide, for specific requirements.
3. Adjoining sheets of EPDM membrane are spliced together using 3" wide QuickSeam Splice Tape/QuickPrime Plus with a 6" wide QuickSeam Flashing installed over the 3" wide QuickSeam Splice Tape/QuickPrime Plus.
4. UltraPly TPO membrane is spliced together with a minimum 1-1/2" wide hot air weld with a reinforced UltraPly membrane, installed over the seams and heat welded along all edges.
5. Various components, dependant on desired planting schedule, allowable loads and the climactic region of the project, are installed above the membrane. These components can include:
 - Root barriers
 - Extruded polystyrene insulation
 - Water retention mats
 - Drainage boards
 - Drainage gravel
 - Filter fabrics
 - Vegetated growth medium

B. ROOF GARDEN DEFINITIONS

1. Intensive Greening (Deep) Firestone Garden Roofing Systems

A planting system of greater depth (soil depth greater than 8") that requires regular maintenance, such as watering, fertilizing and mowing/weeding. A variety of plants are available including sod grass, annual or perennial flowers, shrubs and even small trees. This system typically requires a structural concrete roof deck to support the larger dead load. An irrigation system may be utilized in these assemblies, as required. The anticipated weight above the membrane assembly is generally greater than 25 pounds per square foot.

2. Simple Intensive Greening (Medium Depth) Firestone Garden Roofing Systems

A medium depth planting system (soil depth of 4" to 8") where recommended plants include sedums, herbs, grasses and other vegetation which can grow in this depth of media. In temperate climates, non-irrigated systems can be provided without difficulty; however drip, mist or spray irrigation systems may be required to support more diverse plant types or for installations in semi-arid climates. The anticipated weight above the membrane assembly is generally between 15 and 25 pounds per square foot.

3. Extensive Greening (Shallow) Firestone Garden Roofing Systems

A shallow planting system (less than 4" in depth) ideally suited for areas that will receive little maintenance. Recommended plants include sedums, herbs and grasses. The anticipated weight above the membrane assembly is generally less than 15 pounds per square foot.

1.02 APPLICABILITY

A. GENERAL:

1. Firestone roof systems are applicable for many commercial and industrial roofing applications.
2. Parameters of this manual outline the minimum requirements for a Firestone Red Shield warranty.
3. Firestone roof systems may not be applicable, without special consideration, if subject to local, regional, or national building code requirements or testing agency restrictions. It is the building owner or his design professional's responsibility to consult with the controlling code agency official(s) to determine specific requirements.

B. CONSULTATION:

The Roof System Solutions Group at Firestone Building Products is available for consultation with respect to any deviations from current Firestone requirements and standards.

C. DESIGN:

1. Firestone recommends that a design professional be consulted to assure proper design, installation, and conformance to building codes, etc.
 - a) The building owner or his design professional should be consulted to ensure structural conditions are sufficient to support the anticipated load of the completed roof installation.
 - b) Statements in this design guide are provided in good faith with the expectation that a design professional be consulted prior to any job decisions being made.
 - c) The design professional should review the proposed system assembly for its applicability on each project.
 - d) Firestone does not review or calculate dew point analyses and therefore, does not accept responsibility for damage due to recurrence rate or location of dew point. Although not all projects require a vapor retarder, a design review must be considered for all projects to determine if a vapor retarder may be necessary.
 - e) Provide a thermal barrier, if necessary, to meet local building code requirements.
2. Consider the effect of loads on the structure/decking due to the loading/staging of materials as a part of system installation. The project designer should specify the load limitations to be observed by the Firestone Licensed Applicator.

D. CONDITIONS:

1. The following conditions require special consideration and may not be warrantable. Firestone recommends that a design professional be involved in the design process. For additional assistance, consult the Roof System Solutions Group at Firestone Building Products.
 - Substrates that do not provide adequate fastener or adhesion pullout resistance
 - Buildings with high interior humidity such as swimming pools
 - Roof decks that do not provide adequate fastener pullout resistance
 - Cold storage and freezer facilities
 - Cold storage facilities constitute a special condition. A designer familiar with cold storage construction and vapor migration should be consulted in the design of the roof system
2. Pullout Tests: Due to the variety of physical conditions that can affect pullout resistance, Firestone recommends that on-site tests be conducted by an independent testing laboratory, the manufacturer’s representative or the roofing contractor, to determine actual pullout values.

The following deck types are those which may not provide sufficient pullout resistance:

- Steel decks thinner than 22 gauge (0.76 mm)
 - Concrete less than 3000 psi (20,684 kPa)
 - Any other substrate that does not have a published pullout capacity greater than the minimum required for the applicable roof system
- a) The sections of the substrate where integrity is most in question should be used for testing. Test areas must include corners and perimeters. The minimum number of pullout test required is as follows:

Roof Size	Number of Pull-Out Tests
Less Than 10,000 sf (929 m ²)	6
10,000 sf - 50,000 sf (929 m ² – 4,645 m ²)	10
50,000 sf - 100,000 sf (4,645 m ² – 9,290 m ²)	20
Over 100,000 sf (9,290 m ²)	1 per 5,000 sf.

3. When new construction or other conditions prevent preliminary on-site pullout tests, the fastener manufacturer should supply estimated pullout values for design and bid purposes. On-site verification of the pullout capacity must be confirmed prior to system installation. (Consider requesting a unit price bid for potential increased fastening requirement.)

E. MOLD:

The formation or presence of mold or fungi in a building is dependent upon a broad range of factors including, but not limited to, the presence of spores and nutrient sources, moisture, temperatures, climatic conditions, relative humidity, and heating/ventilating systems and their maintenance and operating capabilities. These factors are beyond the control of Firestone and Firestone shall not be responsible for any claims, repairs, restoration or damages relating to the presence of any irritants, contaminants, vapors, fumes, molds, fungi, bacteria, spores, mycotoxins, or the like in any building or in the air, land, or water serving the building.

F. WARRANTY:

1. General:

- a) Issuance of a warranty for projects outside the US must be submitted to the appropriate Firestone International Office for consideration prior to bidding.
- b) Only Firestone-supplied components are eligible to be covered as part of the Firestone warranty.
- c) Parameters of this manual outline the **minimum** requirements for a Firestone RedShield warranty. Local code and insurance requirements may require specific enhancements
- d) A 10, 15, or 20-year System warranty is available for a charge on commercial buildings and applies only to products manufactured or marketed by Firestone Incorporated. The membrane system is defined as membrane, flashings, adhesives, sealants and other Firestone brand products utilized in this installation.

2. Where a Firestone Red Shield labor and material warranty is required:

- The roof must be installed according to the current Firestone requirements.
- The Firestone roof system must be installed by a current Firestone Red Shield licensed applicator.
- Upon request by the approved Firestone Licensed Applicator, an inspection will be conducted by a Firestone Technical Representative to ascertain that the membrane roofing system has been installed according to Firestone Building Product's specifications and details. This inspection shall be coordinated prior to installing the "**above membrane roof components**" so access to the membrane is not impaired.

3. The approved Firestone Licensed Applicator must notify Firestone at least three weeks in advance of the applicable inspection dates for coordination purposes.

4. Upon Firestone's inspection and acceptance of the installed roof system, the requested warranty can be issued. Firestone's inspection is not intended as an inspection for benefit of the owner or design professional with respect to contract, building codes or compliance with specifications other than Firestone's. Warranted Firestone roof systems are to be installed only on commercial, industrial, institutional or multi-family commercial housing buildings in the United States and Canada.

5. Access for warranty service: It shall be the owner's responsibility to expose the membrane assembly in the event warranty service is required.

6. LIMITS

- Firestone roof system tie-ins to other roof systems are not warranted by Firestone
- Failure of a flashing terminated to an intermediate element (e.g., metal flashing, insulation, surface treatment, etc.), which itself could fail and admit moisture beneath the membrane is beyond the limits of the Firestone RedShield warranty.

7. CONDITIONS:

- a) Certain situations may arise where Firestone specifications and/or roofing requirements cannot be applied. It may not be possible for Firestone to issue the desired warranty for projects that deviate from current Firestone requirements and standards, unless a written request for approval has been received, reviewed and approved by the Firestone Roof System Solutions Group prior to application of the proposed system.
- b) Firestone roof systems cannot receive a Firestone RedShield warranty if any of the following conditions exist:

- Good roofing practice requires a complete tear-off to the structural deck. Recovering an existing roof system is not an acceptable alternative to removing existing roof components. A substrate with an existing roof membrane left in place is not an acceptable substrate for Firestone Garden Roofing Systems and cannot receive a Firestone RedShield warranty. A complete tear-off of the existing roof system is required.
- Roofs where structural conditions are insufficient to support the load of the completed roof installation and other anticipated loads as identified by the building owner or the design professional.
- Roofing applications for single-family residences.

1.03 QUALITY ASSURANCE

A. JOB SITE CONSIDERATIONS:

1. Protect all components of the Firestone roof systems including the finished areas of the Firestone Roof System from damage, Including, but not limited to:
 - Damage that may result from the continued construction process
 - Discharges from such as petroleum products, greases, oils (mineral and vegetable), animal fats and other byproducts, which may come in contact with the membrane
 - Protect Firestone roof system components from direct contact with continuous steam or heat sources when the in-service temperature is in excess of 180 °F (82 °C)
 - Asphalt, coal tar, oil base or plastic roof cements, and re-saturated roof products are not to be used in direct contact with the waterproofing components of the Firestone Garden Roofing Systems
2. Store Firestone UltraPly TPO membrane in the original undisturbed plastic wrap in a manner to protect it from damage.
3. Flood testing, electronic testing or other leak detection means is strongly advised to check the waterproof integrity of the membrane prior to installing any above membrane components.
4. Insulation must be properly stored and protected from ignition sources, moisture and damage.

B. SAFETY

1. Material Safety Data Sheets (MSDS) must be available at all times. All safety regulations recommended by OSHA and other agencies having jurisdiction should be followed.
2. Fumes from adhesive solvents and asphalt products may be drawn into the building during installation through rooftop intakes. Refer to the Firestone Technical Information Sheet "Recommended Guidelines for Working on an Occupied Building" for specific guidelines when installing adhesives or asphalt products on an occupied building.
3. Keep all adhesives, sealants and cleaning materials away from ALL ignition sources (i.e., flames, fire, sparks, etc.). Do not smoke while using these materials.
4. Consult container labels, Material Safety Data Sheets and Technical Information Sheets for specific safety instructions for all products used on the project.
5. Cold weather application:
 - a) When the outside temperature is below 40 °F (4.4 °C), certain combinations of temperature and humidity may cause condensation on the surface of solvent-based adhesives and primers. If this condition occurs, discontinue the application. When the ambient air conditions no longer cause condensation on adhesive surfaces, re-apply additional adhesive or primer and proceed
 - b) Adhesives, sealants, and asphalt roll-goods should remain in a heated environment between 60 °F and 80 °F (15.5 °C and 26.6 °C) a minimum of 24 hours before installation.
 - c) Materials should be used within four hours of removal from a heated storage area. If materials are not used within that time period, they should be returned to the heated

storage area until the temperature of the material returns to the temperature of the heated storage area. Typically this is 24 hours.

- d) The consistency of sealants, adhesives and primers will begin to thicken as the temperature drops. To minimize this, the following is recommended:
- Start work with sealants, adhesives and primers that have been stored between 60 °F and 80 °F (15.5 °C and 26.7 °C). Insulated heated boxes may be helpful
 - Complete test areas to determine if conditions will cause problems such as condensation with the application of the material
 - Stop the operation or change to another warm container when material becomes too thick to properly apply
 - Do not use heat guns or open flames to dry adhesives and primers
 - If using water-based bonding adhesive, temperatures must be at least 40 °f (4.4 °c) and rising for the material to apply and perform as designed. Longer drying times should be expected for lower temperatures and higher humidity

C. SUBMITTALS:

1. To ensure compliance with Firestone's warranty requirements, all projects should be forwarded to Firestone for review prior to installation.
2. A dimensioned layout of all field splices shall be included along with the project submittals (shop drawing and request for warranty).
3. For all projects, prior to project inspection by Firestone, a final shop drawing must be approved by Firestone.

1.04 SYSTEM DESIGN GUIDELINES

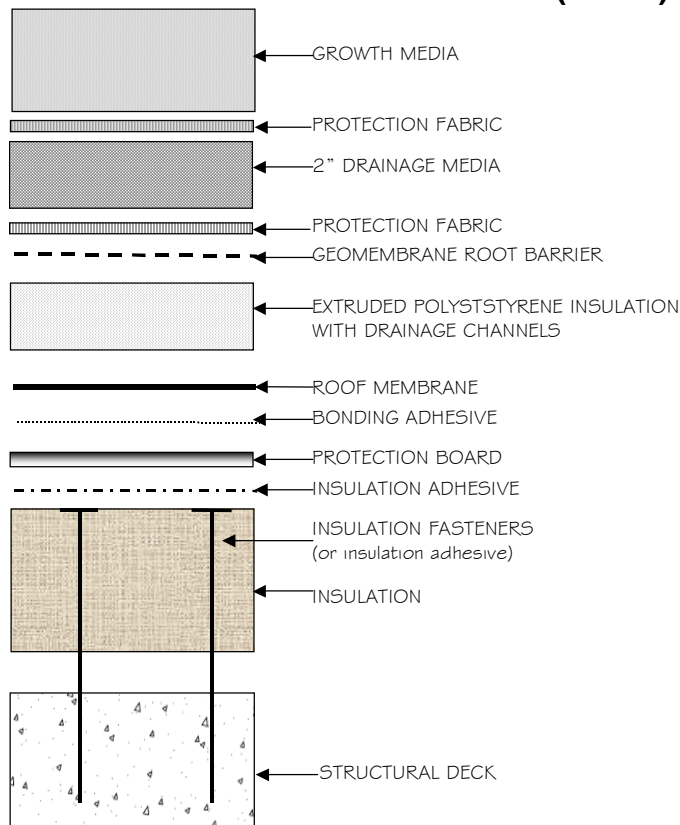
A. INTENSIVE GREENING (DEEP) SYSTEM:

1. A proper substrate shall be provided beneath the waterproofing membrane. This can be accomplished with the use of adhesives or fasteners to secure the roof insulation. The protection board shall be set in adhesive or asphalt as the underlayment for the membrane.
2. The membrane may be a 90-mil Platinum EPDM or an 80-mil UltraPly TPO membrane installed in an adhered fashion.
3. A layer of minimum 2" (5.cm) thick extruded polystyrene insulation with drainage channels is used above the membrane to facilitate drainage and protect the membrane against puncture.
4. A root barrier consisting of 40-mil non-reinforced geomembrane is installed above the insulation and covered with protection fabric and a layer of drainage gravel a minimum of 2" (5.cm) in thickness.

Note: A layer of drainage board may be used as a substitute to the drainage gravel and protection fabric used beneath the growth media and above the root barrier.

5. A second layer of protection fabric will be required above the gravel prior to the installation of the growth media.

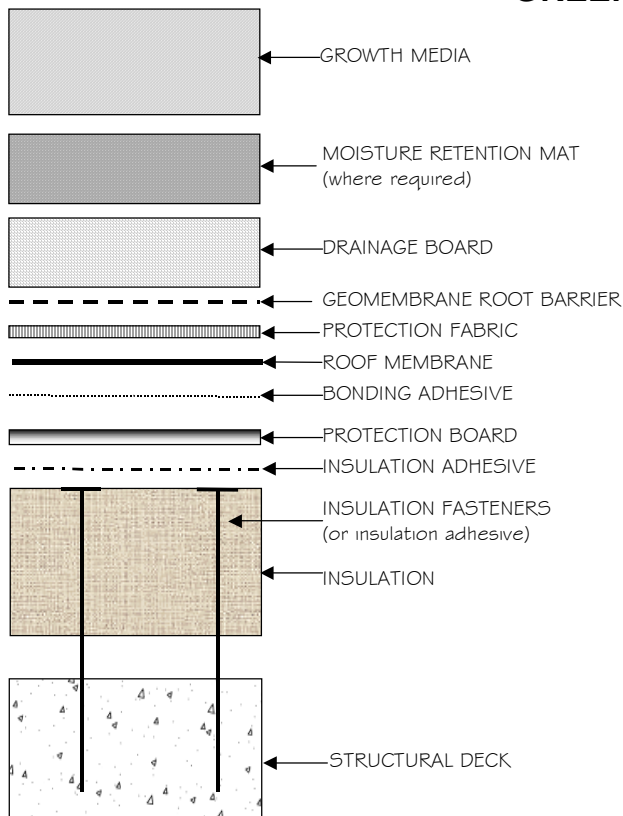
INTENSIVE (DEEP) GREEN ROOF



B. SIMPLE INTENSIVE GREENING (MEDIUM DEPTH) SYSTEM:

1. A proper substrate shall be provided beneath the waterproofing membrane. This can be accomplished with the use of adhesives or fasteners to secure the roof insulation. The protection board shall be set in adhesive or asphalt as the underlayment for the membrane.
2. For a 10 or 15-year warranties, the assembly requires the use of either a 60-mil RubberGard MAX EPDM or a 60-mil UltraPly TPO membrane, installed in an adhered fashion.
3. For a 20 year warranted systems, 90-mil Platinum or 80-mil UltraPly TPO is required and installed in an adhered fashion.
4. A layer of protection fabric is installed above the membrane and covered with a root barrier, consisting of 40-mil non-reinforced geomembrane, and a drainage board.
5. The growth media can be placed either directly onto the drainage board or over a moisture retention mat.

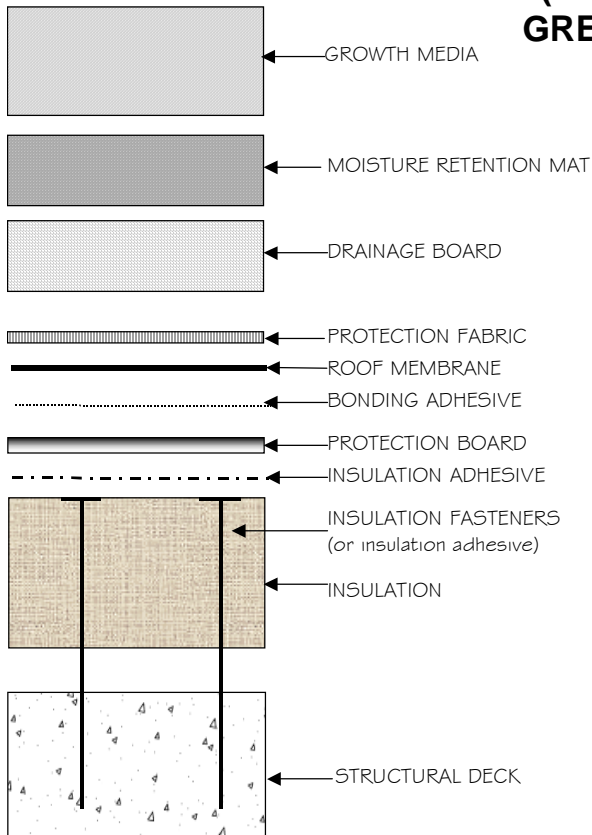
SIMPLE INTENSIVE GREENING (MEDIUM) GREEN ROOF



C. EXTENSIVE (SHALLOW) SYSTEM:

1. A proper substrate shall be provided beneath the membrane. This can be accomplished with the use of adhesives or fasteners to secure the roof insulation. The protection board shall be set in adhesive or asphalt as the underlayment for the membrane.
2. For 10 or 15-year warranties, the membrane shall be a 60-mil RubberGard EPDM or an UltraPly TPO adhered to the protection board.
3. For 20-year warranted systems, a 90-mil Platinum EPDM or a 80-mil UltraPly TPO membrane is required and installed in an adhered fashion.
4. A layer of protection fabric is installed above the membrane and covered with a drainage board and a moisture retention mat.
5. The growth media shall be placed directly onto the moisture retention mat.

EXTENSIVE GREENING (SHALLOW) GREEN ROOF



D. SYSTEM WARRANTY REQUIREMENTS:

		Extensive Greening Shallow Assembly		Simple Intensive Greening Medium Assembly		Intensive Greening Deep Assembly	
Approximate weight of above membrane material * ¹		15 pounds per square foot (73 Kg/m ²)		<25 pounds per square foot (122 Kg/m ²)		>25 pounds per square foot (122 Kg/m ²)	
Growth Media		Required <4" (10 cm) of Depth		Required 4" (10 cm) to 8" (20 cm) of Depth		Required >8" (20 cm) of Depth	
Moisture Retention Mat		Required		Optional		Optional	
Protection Fabric		Optional		Optional		Required 16 oz/yd ²	
Drainage Media		Optional		Optional		Required	
Drainage Board		Required		Required		Optional	
Protection Fabric		Required		Optional		Required 16 oz/yd ²	
		10- 15 year 12 oz/yd ²	20 year 16 oz/yd ²				
Root Barrier		Optional		Required		Required	
Protection Fabric		Optional		Required 16 oz/yd ²		Optional	
Extruded Polystyrene		Optional		Optional		Required Minimum 2" (5 cm)	
Membrane	Warranty Period	10- 15 year	20 year	10- 15 year	20 year	10- 15 year	20 year
	EPDM	60 mil RubberGard Non-reinforced EPDM	90 mil Platinum	60 mil RubberGard MAX Reinforced EPDM	90 mil Platinum	90 mil Platinum	90 mil Platinum
	TPO	60 mil UltraPly	80 mil UltraPly	60 mil UltraPly	80 mil UltraPly	80 mil UltraPly	80 mil UltraPly
Protection Board		Required		Required		Required	
Insulation		Optional		Optional		Optional	
Substrate		See Section 1.05					

- 1 Typical wet soil weighs approximately 100 lbs per cubic foot (1,597 kg per cubic meter). Some mixes of growth media consisting of various types of lightweight growing media such as layers of lightweight substrate made up of sand, pumice, and compost can weigh only 60 lbs/sf (292.6 kg per square meter) when fully saturated. It is the design professionals responsibility to determine the actual weight of the system and to perform a thorough analysis of the roof structure.

1.05 STRUCTURAL DECK

A. GENERAL:

1. The Firestone Garden Roofing Systems depend on a suitable substrate to perform its intended function.
2. Proper structural decking shall be provided by the building owner.
3. The building owner or his design professional must ensure that the building structure is investigated by a registered engineer to assure its ability to withstand the total weight of the specified roofing system, as well as construction loads and live loads, in accordance with all applicable codes. The building owner or his design professional must also designate the maximum allowable weight and location for material loading and storage on the roof.
 - a) The substrate to which the Firestone roof system is installed must be:
 - Structurally Sound
 - Smooth
 - Flat
 - Clean
 - Dry
 - Free of sharp fins, or foreign materials that could damage the material
 - b) For Extensive Greening (Shallow) systems, any roof deck capable of withstanding the roof loading may be accepted.
 - c) For Simple Intensive Greening (medium depth) and Intensive Greening (deep) systems, concrete roof decks are recommended due to the increased weight of the roof assembly when the system is at its maximum water capacity.
 - d) Defects in the roof deck must be reported and documented to the building owner or his design professional for assessment. The Firestone authorized roofing applicator shall not proceed unless the defects are corrected.
4. The building owner or his design professional is responsible for ensuring that all moisture has been removed and/or wet substrate has been removed and replaced in a re-roofing application.

B. PULLOUT REQUIREMENTS:

1. Substrates for membrane / Insulation attachment are required to provide sufficient pullout resistance for the fasteners and the roof system.
2. The minimum pullout resistances for specific systems are as follows:
 - a) Insulation mechanically attached to deck requires a fastener pullout of 300 lbs. (136.1 Kg)
 - b) See the Technical Information Sheet for the specific insulation adhesive when the insulation is adhered to the deck.
3. Pullout Tests: Due to the variety of physical conditions that can affect pullout resistance, Firestone recommends that on-site tests be conducted by an independent testing laboratory, the fastener manufacturer's representative or the roofing contractor, to determine actual pullout values. The following deck type are those which may not provide sufficient pullout resistance:
 - Steel decks thinner than 22 gauge (0.76 mm).
 - Concrete less than 3000 psi (20,684 kPa).

- Plywood or oriented strand board less than 1/2" (12.7 mm) thickness.
- Wood plank less than 3/4" (19mm) thickness.
- All poured or pre-cast gypsum, cementitious wood fiber and lightweight concrete decks.
- Existing masonry or brick.
- Any other substrate that does not have a published pullout capacity greater than the minimum required for the applicable roof system

C. VAPOR RETARDER:

1. To control moisture, a vapor retarder may be necessary to protect certain roofing components when high interior humidity is of concern.
2. The need for a vapor retarder, as well as the type, placement and location of a vapor retarder should be determined by the building owner or his design professional. The list below, are examples of common vapor retarder applications.
 - Six (6) mil polyethylene sheeting taped at laps and to penetrations.
 - Mopped Firestone Type IV or VI Ply Sheet over a nailed Firestone MB Base Sheet.
 - Nailed fiberglass or polyester venting base sheet with 18" (457 mm) laps mopped with hot asphalt.
 - Nailed fiberglass or polyester venting base sheet with asphalt glaze coat (side and end laps must be adhered with hot asphalt).
 - Existing dry and sound uninsulated built-up roof system (all splits and blisters repaired).
 - Mopped Firestone Type IV or VI Ply Sheet over an existing dry and sound uninsulated built-up roof system. If gravel surfaced, then gravel shall be removed by power brooming, vacuuming and spudding.
3. Assure that the method of attachment of the roof system and of the vapor retarder selected are compatible

D. DRAINAGE AND SLOPE:

Proper and adequate drainage of water from the roof membrane surface is required to assure the long-term performance of the roof membrane. A minimum roof slope of 1/8" (3.2 mm) per foot (1%) is recommended for the roof system.

E. WOOD NAILERS:

1. For new construction projects, wood nailers must be kiln-dried (Southern Pine, Douglas Fir) structural grade #2 or better. For re-cover projects and new construction projects where a poured-in-place deck will be used, wood nailers must be pressure treated for rot resistance, #2 or better lumber. Asphaltic or creosote-treated lumber is not acceptable. Lumber treated with other wood preservatives such as Pentachlorophenol, Copper Naphthenate or Copper 8-quinolinolate will adversely affect the membrane when in direct contact and are, therefore, unacceptable.
2. Wood nailers are required at the following locations:
 - All roof edges
 - At all other locations as required by Firestone Details
 - Wood nailers must totally support all sheet metal flanges
3. The building owner or his design professional must specify a wood nailer attachment system that will resist a minimum force of 200 lb per foot (2.9 N/m) in any direction. Firestone fasteners are required for all re-roofing applications. For further clarification, please refer to Factory Mutual Loss Prevention Data Sheet 1-49.

F. EXPANSION JOINTS:

1. Roof expansion joints must be located to accommodate movements caused by thermal expansion and building structural movement.
2. A design professional should be consulted to determine the need for an expansion joint.
3. Consideration for the installation of expansion joints, should be given under the following conditions:
 - Where expansion or contraction joints are provided in the building structural system.
 - Where structural framing elements such as joists, rafters, purlins, or steel decking change direction.
 - Where different types of roof decks such as concrete and steel abut each other.
 - Where additions are connected to existing buildings.
 - At junctions where interior heating conditions change such as a heated space abutting and unheated space.
 - Where movement between vertical walls and the roof deck is anticipated.
 - Note: The conditions above may not be inclusive. Other conditions may exist in which expansion joints should be considered.

1.06 INSULATION

A. GENERAL:

1. Insulation provides a substrate for the proposed roof system as well as insulation for the building.
2. Firestone has developed a comprehensive offering of roofing fasteners and adhesives for a variety of roofing substrates.
 - a) It is acceptable to combine fastener and adhesive attachment methods in multi-layer applications of insulation. The protection board must be adhered to a suitable substrate.
 - b) When mechanically fastening insulation using fasteners and plates, Firestone HD Fasteners must be used for a 20 year Red Shield warranty.
 - c) Refer to specific Firestone Technical Information Sheets for installation and fastening requirements.
3. Only Firestone brand insulation can be included in a Firestone Red Shield warranty.
4. Insulation thickness requirements may vary for code compliance.
5. Tapered insulation thickness may be below the 1.0" (38 mm) minimum thickness. In areas where this occurs, the insulation must be fastened at a rate of one (1) fastener and plate per two (2) square foot (0.22 sq. m). If possible, install the tapered insulation first, covered by the flat stock.
6. On metal decks, the edges of insulation boards running parallel with the deck should be supported by the top flange. Edges of insulation boards running parallel with the deck should be supported by the top flange.

B. PROTECTION BOARD:

1. Warranted Firestone Garden Roofing Systems require a minimum of 1/2" (12.7mm) DensDeck Prime™ or 1.5" (38.1 mm) HailGard as a protection board.
2. The protection board must be adhered to the appropriate substrate. Mechanical fasteners are not an acceptable method for the attachment of the protection board.

1.07 INSULATION ATTACHMENT

Firestone has developed a comprehensive offering of roofing fasteners and adhesives for a variety of roofing substrates. It is acceptable to combine fastener and adhesive attachment methods in multi-layer applications.

A. MECHANICAL ATTACHMENT:

1. The insulation must be installed in accordance with the fastening rate and pattern for the applicable system, as shown on the Technical Information Sheet for the selected insulation.
2. Fastening rates and patterns may vary for code compliance. Contact local code or insurance official before contacting the Roof System Solutions Group at Firestone Building Products.
3. Insulation must be fastened with appropriate Firestone fasteners and insulation plates.
4. The top layer of protection board must be adhesive-attached. Mechanical attachment of the protection board directly beneath the membrane is not acceptable for Firestone Garden Roofing Systems.

B. ASPHALT ATTACHMENT:

1. Hot steep asphalt (ASTM D 312 Type III or Type IV) may be used to attach the insulation and the protection board beneath the roof system.
2. When using hot asphalt for attachment:
 - a) The insulation must be no larger than 4' X 4' (1.2 m X 1.2 m).
 - b) Stagger all insulation joints from adjoining boards.
3. The following substrates may be used with asphalt attachment of insulation and the protection board:
 - a) Poured-in-Place or pre-cast structural concrete decks which have been primed at a rate of 1-1/2 to 2 gallons per 100 square feet (0.61 to 0.82 L/sq. m) with an ASTM D 41 asphalt primer.
 - b) Mechanically attached base sheets that have been fastened in accordance with Firestone requirements.
 - c) Mechanically attached insulation that has been fastened in accordance with Firestone requirements.
4. Assure compliance to all building codes when using hot asphalt.
5. Assure that all health and safety measures are followed when installing hot asphalt to protect the installers as well as occupants of the building.

C. ADHESIVE ATTACHMENT:

1. Firestone I.S.O.SPRAY™, Firestone I.S.O. Twin Pack Insulation Adhesive, and Firestone I.S.O.FIX®:
 - a) The insulation must be no larger than 4' X 4' (1.2 m X 1.2 m).
 - b) Firestone I.S.O.SPRAY™, Firestone I.S.O. Twin Pack Insulation Adhesive, and Firestone I.S.O.FIX® must be applied in accordance with the installation instructions and TIS sheets.

1.08 MEMBRANE SECUREMENT OPTIONS FOR SINGLE-PLY SYSTEMS

A. GENERAL:

1. The Firestone Garden Roofing System membrane must be bonded to the approved substrate with Firestone Bonding Adhesive or Water-Based Bonding Adhesive appropriate for the membrane.
2. Compliance with all installation criteria is required for the issuance of a Firestone warranty.
3. Additional attachment requirements may be necessary to comply with the local building code.

B. BASE TIE-INS AND MEMBRANE TERMINATIONS:

All base tie-ins and membrane terminations must be attached to substrates which will resist a minimum of 200 lbf (89 kN) force in any direction

1.09 MEMBRANE AND FLASHING SPLICES

A. RUBBERGARD EPDM AND PLATINUM EPDM:

1. Field and Flashing Lap Splices:
 - a) Complete all lap splices using Firestone 3" QuickSeam Splice Tape, followed by the application of 5" QuickSeam flashing over the completed splice.
 - b) Refer to Firestone details for information regarding specific requirements.
2. Perimeter Base Flashings:
 - a) Base Flashings must be completed using Firestone QuickSeam Reinforced Perimeter Fastening Strip.
 - b) Refer to Firestone details for information regarding specific requirements.
3. Curb Flashings:

Curb flashings must be completed using Firestone QuickSeam Reinforced Perimeter Fastening Strip as the base tie-in. For curbs where this is not practical, the membrane may be attached to the vertical surface using Firestone metal or polymer batten strip and the appropriate Firestone Fastener. The curb must be flashed using Firestone QuickSeam Curb Flashing or cured RubberGard .060" (1.5 mm) or Platinum .090" (2.3 mm) membrane and spliced to the field sheet using 3" QuickSeam Tape followed by the application of 5" QuickSeam flashing over the completed splice.
4. All additional splicing requirements contained in the Firestone Platinum specifications must be strictly followed.

B. ULTRAPLY TPO MEMBRANE AND FLASHING SPLICES:

1. UltraPly TPO membrane is spliced together with a minimum 1-1/2" wide hot air weld with a 6" wide reinforced UltraPly membrane, installed over the seams and heat welded along all edges. T-joint patches must be installed at all intersections of field seams.
2. Note: When 6" wide reinforced UltraPly membrane is used to overlay field splices, splice intersections ("T" joints) between UltraPly membrane and field splice overlay must be overlaid with a heat welded 6" x 6" section of UltraPly non-reinforced flashing. Refer to Firestone's UltraPly specifications for specific requirements
3. Heat weld the UltraPly membrane sheets using the Automatic Heat Welder or hot air hand welder and silicone roller. A minimum 1-1/2" wide heat weld between adjoining sheets is required.
4. All cut edges with scrim exposed must be sealed with Firestone UltraPly TPO Cut Edge Sealant.
5. Membrane left exposed for more than 12 hours must be cleaned prior to any welding activity
6. All additional splicing requirements contained in our UltraPly TPO Adhered Roofing System specifications must be strictly followed (i.e., membrane cleaning/preparation, heat welding procedures, equipment setup, seam probing etc.).
7. For instructions, refer to of the Firestone UltraPly TPO Roofing Systems Application Guide.

1.10 FLASHINGS

A. GENERAL:

1. Walls, curbs, skylights and all other penetrations through the membrane must be flashed in accordance with Firestone's published specifications/details for the applicable membrane specified.
2. Refer to the system application and detail sections. Extended warranties may require special flashing applications.

B. WALL/CURB FLASHING MATERIALS AND REQUIREMENTS:

1. Walls, curbs, skylights and all other penetrations through the membrane must be flashed in accordance with Firestone's published specifications/details for the applicable membrane specified.
2. All existing flashing must be removed prior to the application of new flashing. New membrane flashing must not conceal weep holes or cover existing throughwall counterflashing.
3. In areas where metal counterflashing is used as the vertical termination, the counterflashing must be sealed with a rubber grade caulking to prevent moisture migration behind the new wall flashing.
4. Install surface mounted reglets and compression bar terminations directly to the wall surface.
5. Vertical field splices at walls, curbs, etc., must be overlaid in the same fashion as the field splices.
6. When using 90-mil EPDM membrane, all pipe flashing details shall conform to Firestone's Adhered 30 year warranty specification.
7. Uncured Elastoform Flashing or Pressure-Sensitive Uncured Flashing must be limited to overlayment of vertical seams (as required at angle changes), or to flash inside/outside corners, vent pipes, scuppers and other unusually shaped penetrations where the use of premolded pipe seals, cured EPDM membrane or Pressure-Sensitive Flashing (semi-cured) is not practical.
8. Note: Even when working in elevated temperatures, in most cases a heat gun will be required to elevate the temperature of uncured Elastoform Flashing to a higher than warm tool temperature (which is between 105°F (40°C) and 110° F (43°C) to permit proper forming of the uncured flashing.
9. Firestone's Termination Bar, in conjunction with Water Cut-Off Mastic, must be installed under all metal counterflashings used for vertical wall terminations.

C. ROOF DRAINS:

1. On roof gardens with deeper growth media, drains should be covered with a perforated "drain viewing box" with removable lid (at the growth media surface) for inspection purposes.
2. 1-1/2" nominal diameter rounded river washed gravel is applied around the "viewing box" (minimum 12" in width) to promote drainage.

3. On Extensive Greening (Shallow) and some Simple Intensive Greening (Medium - with shallower soil depth) Firestone Garden Roofing System assemblies, standard cast iron compression ring clamping drains may be able to be used with 1-1/2" nominal diameter rounded river washed gravel applied around the drain sump area (minimum 12" in width) for drainage; however, "drainviewing boxes" are recommended.

1.11 APPLICATION OF FIRESTONE GARDEN ROOFING SYSTEM COMPONENTS

A. GENERAL:

1. Limit traffic over completed roof membrane sections to essential personnel only.
2. Heavily traveled areas (staging areas, corridors used to transport roof components) must be protected using ½” thick plywood or other sheathing.

B. WATER TEST:

1. Before the installation of the components above the membrane of a Firestone Garden Roofing System, a water test is strongly advised to ensure the waterproof integrity of the membrane system.
2. After the membrane and flashings have been in place approximately 24 hours, plug drains and provide necessary barriers to contain water.
3. “Flood” membrane surface with water to a depth of 2” for a period of 24 hours.
4. Inspect for leaks and repair membrane if defects are found. Retest after repairs have been made.
5. Note: On UltraPly TPO systems, electronic testing (Electric Field Vector Mapping – EFVM) may be used to test membrane/flashing for defects.
6. Sweep the surface of the membrane to remove all debris and loose or foreign material.

C. PROTECTION FABRIC:

1. Extend protection fabric up walls, curbs, etc. to the height of the top of the growth media layer.
2. Provide a minimum 2” side, and end overlap on each of the layers of the protection fabric
3. Under windy conditions, provide temporary ballast to prevent wind disturbance. It is recommended to install the additional “above roof components” over the protection fabric soon after its placement to prevent disturbance.

D. EXTRUDED POLYSTYRENE INSULATION (FOR INTENSIVE GREENING FIRESTONE GARDEN ROOFING SYSTEMS):

1. Install loose laid insulation directly over the membrane with all joints tightly butted.
2. Extend insulation up walls, curbs, etc. to the height of the top of the growth media layer.

E. ROOT BARRIER:

1. The root barrier is loose-laid, with adjacent sheets overlapped a minimum of 2” in preparation for splicing.
2. Splicing surfaces shall be clean. Dirt/contaminants shall be removed from splice areas with specified membrane cleaner.
3. Specified membrane cleaner must be used to remove surface oxidation on the root barrier surface when the material has been exposed to the elements for 7 days. Apply membrane cleaner with a clean white rag. Prior to heat welding, wipe the surface of the root barrier

where the cleaner has been applied with a clean, dry, white rag to remove all cleaner residues.

4. Extend root barrier up walls, curbs, etc. to the height of the top of the growth media layer.

F. DRAINAGE BOARDS:

1. On Intensive Greening (deep) applications, drainage board may be used as a substitute to the 2" drainage gravel and protection fabric used beneath the growth media and above the root barrier
2. Place drainage board panels so water flows with the overlap, not against it.
3. Install the drainage panels with the fabric side facing upward. The first panels should be positioned with the flanged edge facing uphill.
4. Extend drainage boards up walls, curbs, etc. to the height of the top of the growth media layer.

G. MOISTURE RETENTION MAT:

1. Required for Extensive Greening (shallow) systems; optional for Simple Intensive Greening (medium depth) garden systems.
2. Unroll moisture retention mat and loose lay over the drainage board overlapping side and end laps a minimum of 2".
3. Under windy conditions, provide temporary ballast to prevent wind disturbance. It is recommended to install the growth media over the moisture retention mat soon after its placement to prevent disturbance.
4. Extend the moisture retention mat up walls, curbs, etc. to the height of the top of the growth media layer.

H. DRAINAGE GRAVEL:

1. On Intensive Greening (deep) garden systems, a minimum 2" thick layer of drainage gravel shall be installed over the protection fabric (which is installed over the root barrier and extruded polystyrene insulation above the membrane).
2. Drainage gravel shall be leveled and overlaid with protection fabric prior to placement of the growth media.
3. Note: On Intensive Greening (deep) garden applications, drainage board may be used as a substitute to the drainage gravel and the protection fabric used beneath the growth media and above the root barrier.

I. GROWTH MEDIA/PLANTING:

1. Spread engineered soil mixes to the specified depth, plus 15%. Dispense to locations in a manner that will not overload the structure.
2. Thoroughly soak soil with water using a sprinkler or hand sprayer.
3. Plant vegetation in accordance with the landscape architect/designer plans and instructions for the intended soil and climate.

1.12 PRODUCTS

A. INSULATION (OPTIONAL, INSTALLED BETWEEN PROTECTION BOARD AND STRUCTURAL DECK):

1. Firestone ISO 300 1.0"(25.4 mm) minimum thickness
2. Firestone ISO 95+ (flat or tapered) 1.0"(25.4 mm) minimum thickness
3. Firestone Composite Insulation 1.5"(38.1 mm) minimum thickness
4. DensDeck 1/4" (6.3 mm) minimum thickness.

B. PROTECTION BOARD (REQUIRED):

1. DensDeck Prime 1/2"(12.7mm) minimum thickness
2. Firestone HailGard 1 1/2"(38.1 mm) minimum thickness

C. MEMBRANE

		Extensive Greening Shallow Assembly		Simple Intensive Greening Medium Assembly		Intensive Greening Deep Assembly	
Warranty Period		10- 15 year	20 year	10- 15 year	20 year	10- 15 year	20 year
Membrane	EPDM	60 mil RubberGard Non-reinforced EPDM	90 mil Platinum	60 mil RubberGard MAX Reinforced EPDM	90 mil Platinum	90 mil Platinum	90 mil Platinum
	UltraPly TPO	60 mil UltraPly	80 mil UltraPly	60 mil UltraPly	80 mil UltraPly	80 mil UltraPly	80 mil UltraPly

D. EXTRUDED POLYSTYRENE:

1. Extruded Polystyrene Insulation – Dow Roofmate or Foamular 404/604, a minimum 40/60-psi compressive strength, moisture resistant, closed cell polystyrene foam insulation with drainage channels along board edges to promote drainage at the membrane level. Installed directly over the roof membrane in Intensive Greening (deep) garden assemblies. Available in 2' x 8' board sizes with a thickness of 1" to 4".

E. PROTECTION FABRIC:

1. Polypropylene non-woven needle punched fabric, stabilized to resist soil chemicals, mildew, and insects and is non-biodegradable.

Property	Test	Units	Typical Value	
			12 oz/yd ² (285 gram/m ²)	16 oz/yd ² (380 gram/m ²)
Puncture Resistance	ASTM D 4833	Lbs (kN)	130 (.58)	235 (1.05)
Mullen Burst	ASTM D 3786	Psi (kPa)	400 (2,756)	750 (5,167)
Elongation	ASTM D 4682	%	50	50
Thickness	ASTM 5199	Mils (mm)	90 (2.3)	150 (3.8)

F. ROOT BARRIER:

1. Used in Intensive Greening (deep) and Simple Intensive Greening (medium depth) Roof Garden Systems.

a) 40 mil non-reinforced geomembrane: A non-reinforced polypropylene sheet specifically formulated for use in below grade applications to resist root growth and soil bacteria. Adjoining sheets are heat welded.

Property	Test Method	Typical Value
Thickness		15 mils
Weight		1.1 oz/ft ²
Color		Red
Tensile Strength	ASTM D 882	1,628 psi
Elongation	ASTM D 882	77%
Cracking or Delamination (@ 20 ° F)	ASTM E 154-12	Passes
Puncture Resistance	ASTM E 154-10	124.4 lbs
Perm Rating	ASTM E 96	.008
Classification A, B, C	ASTM E1745	Exceeds Class A

G. DRAINAGE BOARD:

1. High impact polystyrene core with “cups” and pierced holes allowing water retention and drainage. A non-woven polypropylene filter fabric is bonded to the retention side of the molded core to prevent passage of particles into the water reservoirs. Designed to retain water in Extensive Greening and Simple Intensive Greening Roof Gardens while allowing excess water to the drainage system. Installed over protection fabric.

Property	Test Method	Units	Typical Value	
CORE				
Thickness	ASTM D 1777	in (mm)	.40 (10.16)	
Compressive Strength	ASTM D 1621	Psf (kPa)	15,000 (718)	
Reservoir Capacity	TCM-0207	In ³ /ft ³	10 (1,775)	
Percolation Flow Rate (1 punched Hole/ft ²)	TCM-G0163	Gpm/ft ² (l/min/m ²)	0.141 (0.503)	
Retention Performance	TCM-G0163	%	31	
Percolation Flow Rate (2 punched Hole/ft ²)	TCM-G0163	Gpm/ft ² (l/min/m ²)	0.197 (0.704)	
Retention Performance	TCM-G0163	%	18.3	
Percolation Flow Rate (2 punched Hole/ft ²)	TCM-G0163	Gpm/ft ² (l/min/m ²)	0.237 (0.847)	
Retention Performance	TCM-G0163	%	17	
Fabric			Woven	Nonwoven
Apparent Opening Size	ASTM D 4751	US Standard Sieve (mm)	40 (0.42)	70 (0.21)
Water Flow Rate	ASTM D 4491	Gpm/ft ² (l/min/m ²)	145 (5,907)	140 (5,698)
Grab Tensile Strength	ASTM D 4632	Lbs (kN)	365 (1.62)	100 (0.45)

H. DRAINAGE MEDIA:

Granular Drainage Media – Drainage gravel applied in Intensive Greening (deep) garden systems to a minimum depth of 2”.

I. MOISTURE RETENTION MAT:

A nominal 24.3 oz/yd², 0.3” (7.9 mm) thick mat with a density of 6.46 lbs/ft³ (103 Kg/m³) consisting of needle-punched, recycled synthetic fibers designed to retain moisture in Extensive Greening and Simple Intensive Greening Roof Gardens.

J. GROWTH MEDIA:

Growth media soils should be a mixture of mineral and organic soil components and shall be selected by the landscape architect/designer or other appropriate landscape professional for the intended vegetation.

K. VEGETATION:

Sedums, grasses, herbs, flowers, shrubs, small trees, etc., to be selected by the landscape architect/designer or other appropriate landscape professional and intended for the garden type (Intensive, Simple Intensive Greening or Extensive Greening) and soil selected.

L. "HARDSCAPE" ITEMS:

1. Individual concrete plaza pavers – 2' x 2' x 2" thick precast concrete pavers weighing a minimum of 18 psf with a minimum compressive strength of 6500 psi.
2. Paver Pedestals – Rubber paver pedestals to elevate the surface of the pavers above the roof membrane and promote positive drainage and protection from freeze/thaw.
3. Stone Ballast – Nominal 1-1/2" diameter rounded water worn gravel which conforms with ASTM D448, gradation size #4, applied at a minimum of 10 pounds per square foot.
4. Other – Products such as concrete curbs, landscape lumber (wood timbers, etc.) or other desired landscape products suitable for this application. Used to transition between Extensive Greening, Simple Intensive Greening and Intensive Greening GreenRoofing areas to act as a "growth media stop".