



ANSI/SPRI VF-1

External Fire Design Standard for Vegetative Roofs

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Disclaimer

This standard is intended for use by architects, engineers, roofing contractors, and owners of low-slope roofing systems. SPRI, its members and employees do not warrant that this standard is proper and applicable under all conditions.

1.0 Introduction

This design standard provides a method for designing external fire spread resistance for *Vegetative Roofing Systems*. It is intended to provide a minimum design and installation reference for those individuals who design, specify, and install *Vegetative Roofing Systems*. It shall be used in conjunction with the installation specifications and requirements of the manufacturer of the specific products used in the *Vegetative Roofing System*. See Commentary C1.0.

2.0 Definitions

See Commentary C2.0.

The following definitions shall apply when designing a *Vegetative Roofing System*.

2.1 Area Divider

An area of the roof that meets Class A fire classification requirements when tested per ASTM E108.

2.2 Ballast

The weight provided by stones, pavers or light-weight interlocking paver systems to provide uplift resistance for roofing systems that are not adhered or mechanically attached to the roof deck. The inorganic portion of *Growing Media* can be considered *Ballast* if vegetation nominally covers the visible surface of the *Growing Media* or the *Growing Media* is protected by a system to prevent wind erosion.

2.3 Border Zone

The region around the edge of the vegetative plantings, where no vegetation exists. It is frequently the perimeter of the roof area, and areas around *Penetrations* and drains. See Commentary C2.3.

2.4 Combustible Material

Any material that does not comply with the requirements of Test Method E136.

2.5 Fire Barrier

A fire-resistance-rated wall assembly of materials designed to restrict the spread of fire in which continuity is maintained.

2.6 Firebreak

A *Firebreak* is a section of the roof that is covered with stone *Ballast* or concrete pavers and acts to slow or stop the progress of a rooftop fire.

2.7 Growing Media

An engineered formulation of inorganic and organic materials including, but not limited to, heat-expanded clays, slates, shales, aggregate, sand, perlite, vermiculite and organic material including but not limited to compost worm castings, coir, peat, and other organic material. See Commentary C2.7.

2.8 Irrigation System

A system which delivers moisture to the *Growing Media* making it available for plant use.

2.9 Non-Combustible Material

Any material that complies with the requirements of Test Method E136.

2.10 Penetration

An object that passes through the roof structure and rises above the roof deck/surface. *Penetrations* consist of, but are not limited to, mechanical buildings, penthouses, ducts, pipes, expansion joints and skylights. See Commentary C2.10.

2.11 Vegetative Roofing System

An assembly of interacting components designed to waterproof a building's top surface that includes, by design, vegetation and related landscape elements. See Commentary C2.11.

3.0 General Design Considerations

3.1 Roof Structure Design or Evaluation

The building owner shall consult with a licensed design professional to verify that the structure and deck will support fully-hydrated *Growing Media*, vegetation and other material or objects installed on the roof deck in combination with all other design loads.

3.2 Roof Deck Waterproofing Layer or Roof Cover Requirements

The roof cover specified for use in the vegetative system shall meet the recognized industry minimum material requirements for the generic membrane type, and shall meet the specific requirements of its manufacturer. When the roof cover is not impervious to root penetration a root barrier shall be installed. See Commentary C3.2.

3.3 Slope

This Design Standard is limited to roof slope designs up to 2:12. For slopes greater than 2:12, a licensed design professional experienced in vegetative roof design shall provide the design and the design shall be approved by the authority having jurisdiction. See Commentary C3.3.

3.4 Firebreaks

Where required *Firebreaks* shall be installed to provide a minimum 6-ft wide (1.8 m) continuous border.

3.5 Area Divider

Where required an *Area Divider* shall be installed to provide a minimum 13-ft wide (4 m) separation zone.

3.6 Border Zone

A minimum 3-ft wide (1 m) continuous border free of vegetation and *Growing Media*.

3.7 Other Design Considerations

The *Vegetative Roofing System* shall comply with all design requirements as determined by the Building Code or the authority having jurisdiction. See Commentary C3.7.

4.0 Vegetative Roofing System Requirements

See Commentary C4.0.

- 4.1 The waterproofing system below the vegetation shall be tested per ASTM E108 and meet the fire classification requirements of the authority having jurisdiction.

4.2 Fire Protection for Roof Top Structures, Joints and Penetrations

A *Border Zone* (See Section 3.6) shall be provided where *Vegetative Roofing Systems* abut *Non-Combustible* rooftop structures, or joints and *Penetrations*. See Commentary C4.2.

4.3 Spread of Fire, Protection for Large Area Roofs

An *Area Divider* as described in Section 3.5 shall be used to partition the roof area into sections not exceeding 15,625 ft² (1,450 m²), with each section having no dimension greater than 125 ft (39 m). See Commentary C4.3.

4.4 Spread of Fire, Protection for combustible features that are part of the green roof design, but not part of the building structure

An *Area Divider* shall be installed around combustible features that are part of the vegetative roof design. See Commentary C4.4.

4.5 Fire Hydrants

Access to one or more fire hydrants or stand pipes shall be provided.

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4.6 Firebreak

Firebreaks (See Section 3.4) are required where *Vegetative Roofing Systems* abut combustible vertical surfaces and when terminating at a *Fire Barrier*.

5.0 Maintenance

Maintenance shall be provided as needed to sustain the system by keeping vegetative roof plants healthy and to keep dry foliage to a minimum; such maintenance includes, but is not limited to irrigation, fertilization, weeding. Excess biomass such as overgrown vegetation, leaves and other dead and decaying material shall be removed at regular intervals not less than two times per year. Provision shall be made to provide access to water for permanent or temporary irrigation. The requirement for maintenance shall be conveyed by the designer to the building owner, and it shall be the building owner's responsibility to maintain the *Vegetative Roof System*. See Commentary C5.0.

Commentary to VF-1

This Commentary consists of explanatory and supplementary material designed to assist designers and local building code committees and regulatory authorities in applying the requirements of the preceding standard.

The Commentary is intended to create an understanding of the requirements through brief explanations of the reasoning employed in arriving at them.

The sections of this Commentary are numbered to correspond to the sections of the VF-1 standard to which they refer. Since it is not necessary to have supplementary material for every section in the standard, there are gaps in the numbering of the Commentary.

C1.0 Introduction

Green roofs, also known as vegetative roofs, eco-roofs, and rooftop gardens fall into three main categories:

- ▶ Extensive green roofs are installed with 6 inches (152 mm) of *Growing Media* or less; generally weigh between 13 and 30 pounds per square foot (63 and 146 Kg/square meter); and support sedums, herbs and grasses; and
- ▶ Intensive green roofs are installed with more than 6 inches (152 mm) of *Growing Media*, generally weigh between 35 and 100 pounds per square foot (171 and 488 Kg/square meter), and support greater plant diversity;
- ▶ **Semi-intensive** green roofs are roofs that have a mixture of extensive and intensive systems; generally weigh between 25 and 40 pounds per square foot (122 and 195 Kg/square meter); and support plantings seen on both extension and intensive green roof installations.

Vegetative roofs are complex systems consisting of many parts critical to the functioning of the system. To name a few of the components that are generally found in the system, but the system is not limited to these products: insulation, waterproofing membrane, protection mats/boards, root barrier, drainage layer that may include boards for water retention, aeration mat, filter fabric, *Growing Media*, and vegetation. A vegetative roof may consist of more than just *Growing Media* and vegetation, but include such things as walkways, water features, stone decoration, and benches.

A vegetative roof may cover the whole roof or share a portion of the surface with a conventional roofing system. They are versatile systems with many strong attributes including stormwater management, reduction of the heat island effect, and aesthetics.

VF-1 is a minimum standard. Manufacturers and/or designers requirements that exceed the standards minimum requirements can be incorporated into specifications for vegetative roof fire spread.

While the standard is intended as a reference for designers and roofing contractors, the design responsibility rests with the “designer of record.”

C2.0 Definitions

Terms defined in this section appear capitalized and *italicized* throughout this document.

C2.3 Border Zone

For design and installation purposes, the roof surface is divided into the following areas:

Corners: The space between intersecting walls forming an angle greater than 45 degrees but less than 135 degrees.

Corner Areas: The corner area is defined as the roof section with sides equal to 40% of the building height. The minimum length of a corner is 8.5 ft (2.6 m).

Perimeter: The perimeter area has different size definitions depending upon the method of installing the roof. For Ballasted roof systems the perimeter area is defined as the outer boundary with a width measurement equal to 40% of the building height, but not less than 8.5 ft (2.6 m).

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For adhered roof systems it is defined as the outer boundary of the roof width measurement equal to the least of the following measurements; 0.1 x the building width or 0.4 x the building width. The minimum width is 4 ft (1.2 m).

The perimeter area for a ballasted roof is larger due to a concern for *Ballast* blow-off.

Field: The field of the roof is defined as that portion of the roof surface, which is not included in the corner or the perimeter areas as defined above.

C2.7 Growing Media

Inorganic materials used as *Growing Media* are not combustible, however media with high concentrations of organic material can support combustion. Soils with high percentages of organic material can negatively affect the fire resistance of a system.

Sources for *Growing Media* specifications are as follows:

From ASTM:

C549-06	Standard Specification for Perlite Loose Fill Insulation
C330-05	Standard Specification for Lightweight Aggregates for Structural Concrete
C331-05	Standard Specification for Lightweight Aggregates for Concrete Masonry Units
C332-07	Standard Specification for Lightweight Aggregates for Insulating Concrete

Test Methods for classifying material:

C117-04	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
C136-06	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
D5975-96 (2004)	Standard Test Method for Determining the Stability of Compost by Measuring Oxygen Consumption US Composting Council: "TMECC" Test Methods for the Examination of Composting and Compost

Green roof *Growing Media* can be composed of a combination of inorganic and organic materials and should comply with ASTM or FLL performance standards. Different *Growing Media* can perform similar functions. As a result, the materials selected should be based on desired performance function, availability and cost.

C2.10 Penetration

Penetrations may consist of, but are not limited to, mechanical buildings, penthouses, ducts, pipes, expansion joints and skylights. These *Penetrations* may be combustible or fire may have a major impact on their performance. For these reasons, *Penetrations* need to be protected from fire exposure. Section 714 of the International Building Code provides descriptions of various types of *Penetrations* and the firestop requirements for those *Penetrations*.

C2.11 Vegetative Roofing System

Vegetative Roofing Systems are installed over adhered roof systems. There are several types of *Vegetative Roofing Systems* as noted below, and they can be interchanged without affecting the fire performance of the system.

Protected Vegetative Roofing System

A protected *Vegetative Roofing System* consists of vegetation, *Growing Media*, *Ballast* as defined in 2.2, a fabric that is pervious to air and water, insulation, and includes a membrane that provides waterproofing and substrate materials installed over a structural deck capable of supporting the system. Membranes are adhered to the roof deck or supporting insulation.

C2.11 Vegetative Roofing System Using a Fully Adhered Roof Membrane System

A *Vegetative Roofing System* using an adhered membrane system consists of vegetation, *Growing Media*, *Ballast* as defined in 2.2, and includes a membrane that provides waterproofing and is adhered to attached insulation, or adhered directly to a roof deck.

C3.2 Roof Deck Waterproofing Layer or Roof Cover Requirements

List of ASTM references for generic roofing types:

EPDM	ASTM D4637
PVC	ASTM D4434
TPO	ASTM D6878
Hypalon/CPE/PIB	ASTM D5019
KEE	ASTM D6754
SBS	ASTM D6164, 6163, 6162
APP	ASTM D6222, 6223, 6509
BUR	As defined by the standards referenced in the International Building Code
SEBS Hot Mopping Asphalt	ASTM D6152
Fully Adhered Hot-Applied	ASTM D6622

Reinforced Waterproofing System

Building Height

Special consideration shall be given when the building height is greater than 150 ft (45.7 m). Vegetative roofs can be designed using Reference 1 (Kind Wardlaw study), consultation with a wind design engineer, or wind tunnel studies and fire design experience of the specific building and system.

Other Factors

There are other factors that affect the design of the vegetative roof for wind and fire. These include, but are not limited to, building height, building location, pressurized buildings, large openings, eaves and overhangs. See C3.7.

ANSI/SPRI VR-1 *Procedure for Investigating Resistance to Root Penetration on Vegetative Roofs* provides a test method to evaluate the resistance of vegetative roof coverings to normal root and rhizome *Penetration*.

C3.3 Slope

The roof should be sloped to shed water effectively or provide a minimum slope requirement, e.g., 1/4 inch.

C3.7 Other Design Considerations

While outside the scope of this standard, the following design considerations, must be considered by the designer of record and comply with the authority having jurisdiction.

Above Deck Thermal Insulation

The use of above deck thermal insulation is regulated by most building codes. For example, the International Building Code (IBC) only allows its use if it passes either NFPA 276 or UL 1256 when the entire assembly is tested. The designer of record is responsible for verifying that the *Vegetative Roofing System* being used meets the requirements of the authority having jurisdiction regarding the use of above deck thermal insulation.

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Wind Design

Vegetative roofs are not recommended where the design wind speed is greater than 140 mph (62 m/s). However, they can be designed using Reference 1 (Kind Wardlaw study), consultation with a wind design engineer, or wind tunnel studies of the specific building and system. The “authority having jurisdiction” is the only source for approval of designs not covered in this document. ASCE 7 gives guidance on how non-standard conditions should be evaluated. See ANSI/SPRI RP-14 Wind Design Standard for *Vegetative Roof Systems*.

Given that wind standards may often require greater areas of non-vegetative roof, the wind standard will most often determine the size of the perimeter area or *Border Zones*.

C4.0 Vegetative Roof System Requirements

Effective with the 2018 Edition of the International Building Code, *Vegetative Roofing Systems* will be required to meet the same fire classification requirements as the roof covering and roof assembly. Due to the many variables (including plant type, plant condition, depth of *Growing Media*, combustibility of roofing assembly materials, and installation details) and the lack of sufficient experience and test data, classification of exterior fire exposure cannot be made with certainty at the present time. This standard requires that the roof system installed below the *Vegetative Roofing System* meet the fire classification requirements of the authority having jurisdiction. The standard then uses *Border Zones* and *Firebreaks* to protect roof top structures, *Penetrations* and joints that may be on the roof. It also uses roof divider areas consisting of ASTM E108 Class A approved systems to reduce fire spread potential of large vegetative roof areas.

C4.2. Fire Protection for Roof Top Structures and Penetrations

Pavers are often used as Class A or *Non-Combustible* separators. Care should be taken when installing pavers to avoid damaging the membrane. Some manufacturers require a separation material between the paver and the membrane.

C4.3 Spread of Fire, Protection for Large Area Roofs

This standard utilizes *Area Dividers* to reduce the potential for fire spread for large roof areas. Spread of flame for Class A fire is limited to 6 ft (1.8 m), if there is a 6 ft (1.8 m) break separating vegetative areas using Class A material or *Non-Combustible Material* the flame spread is not expected to ignite the nearby area. The dimensions chosen for large area roof limitations are based on FLL requirements and FM Global recommendations (FM Global Loss Prevention Data Sheet 1-35—*Green Roof Systems*, they also coincide with the International Building Codes Area limitations for Assembly buildings.

FM Global has used ASTM E108 to test *Vegetative Roofing Systems*. Modifications of the test standards may be able to provide a meaningful test for selected conditions. However, with all the plant types that could be used in a roof design, the varying weather conditions that occur through the year, and the effects of seasons generate many variables that limit the potential to classify a roof construction. For this reason, Class A classified assemblies are limited to succulent based systems at this time. Refer to Green Roof Plants and *Growing Media* course manual, by Green Roofs for Healthy Cities, for definitions related to vegetative roof plant types.

The FLL believes that a vegetative “hard roof” can be considered to be equivalent to an ASTM E108 Class A Fire Classified roof assembly. The FLL defines a vegetative “hard roof” as those that are:

- ▶ irrigated;
- ▶ regularly maintained;
- ▶ have a substrate no less than 30 mm (1.18 in);
- ▶ made of vegetation that is grasses, succulents and/or perennials;
- ▶ have a substrate with at least 80% inorganic content by mass.

The agreed minimal substrate thickness varies between 30 mm (1.18 in) and 80 mm (3.15 in).

C4.4 Spread of Fire

The intent of this Section is to provide protection for combustible green roof features that are not part of the building structure, such as wood or plastic planters and railings should be dealt with separately.

C5.0 Maintenance

The building owner needs to properly maintain a vegetative roof. One of the important ways of preventing fires is through the use of an *Irrigation System*. The need for irrigation will vary greatly due to climate and types of plants chosen. Designers should be aware that plantings are to be specific for the roof being installed and that rooftops are at best hostile places for vegetation. Dead foliage should be removed and the moisture level of the *Growing Media* should be checked at regular intervals depending upon specific conditions on the vegetative roof. By regularly removing excess biomass that could become fuel for a fire on the rooftop, the risk of fire spreading beyond the 6 ft (1.8 m) Class A fire rated separation is minimized.

Best management practices for maintenance include regular weeding, fertilization, and removal of dead/dormant vegetation in accordance with the recommendations of the green roof provider. Specific directions for the proper maintenance of the vegetative cover should be furnished by the green roof provider.

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References

1. Kind, R.J. and Wardlaw, R.L., Design of Rooftops Against Gravel Blow-Off, National Research Council of Canada, Report No. 15544, September 1976.
2. FM Global: Property Loss Prevention Data Sheets 1-35 Green Roof Systems.
3. FM Global: Approval Standard for Vegetative Roof Systems Class Number 4477 June 2010.
4. FLL Standard "Guideline for the Planning, Execution and Upkeep of Green-Roof Sites", Forschungsgesellschaft Landschaftsentwicklung Landschaftsbau e.V.—FLL, Colmantstr, Bonn, Germany.
5. ANSI/SPRI RP-14, Wind Design Standard for Vegetative Roof Systems, June 2010.
6. Green Roof Plants and Growing Media course manual; Green Roofs for Healthy Cities.
7. ASTM E136 Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
8. ASTM E108 Standard Test Methods for Fire Tests of Roof Coverings.

Documentation

1. Breuning, Jörg, «Fire & Wind on Extensive Green Roofs», Conference Proceedings, Greening Rooftops for Sustainable Communities, Baltimore, MD, 2008.
2. Department for Communities and Local Government, «Fire Performance of Green Roofs and Walls», Government of the United Kingdom, 2013.
3. GRO, «The GRO Green Roof Code», United Kingdom, 2014.
4. Hydrotech Membrane Corporation, «Test inspired by Intermittent Flame Test as per ASTM E 108 Class A», 10 July 2015.
5. Living Roofs, «Green Roofs _ Fire and German Guidelines», www.igraworld.com.
6. RBQ, Critères techniques visant la construction de toits végétalisés, 2015.

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