

ANSI/SPRI VF-1 2023

External Fire Design Standard for Vegetative Roofs

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Suite 421
Waltham, MA 02452
www.spri.org
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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

All words defined within this section are italicized throughout the standard. 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 or UL 790.

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 roofing system* where no vegetation or other *vegetative roofing system* components are installed.

2.4 Combustible Material

Any material that does not comply with the requirements of Test Method ASTM 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 section of the roof that is covered with stone *ballast* or concrete pavers in order 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 ASTM E136.

2.10 Penetration

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

2.11 Registered Design Professional

An individual who is registered or licensed to practice their respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed.

2.12 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 2.12.

3.0 General Design Considerations

3.1 Roof Structure Design or Evaluation

The building owner shall consult with a *registered 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 roofing 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*, or the membrane has not been tested for root *penetration* resistance, a root barrier shall be installed. Root *penetration* resistance shall be confirmed by testing in accordance with *ANSI/SPRI VR-1 Procedure for Investigating Resistance to Root or Rhizome Penetration on Vegetative Roofs*, or other applicable consensus standards. 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 *registered 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 6.0 ft. (1.8 m) wide continuous border.

3.5 Area Divider

Where required, an *area divider* shall be installed to provide a minimum 13.0 ft. (4.0 m) wide separation zone between areas of *vegetative roofing systems*.

3.6 Border Zones

A minimum 3.0 ft. (0.9 m) wide continuous border free of vegetation and *growing media* around rooftop obstructions, such as drains, *penetrations*, curbs, skylights, etc. See Commentary C3.6.

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 or UL 790 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 rooftop structures constructed of *non-combustible materials*, expansion joints, and *penetrations*. See Commentary C4.2.

4.3 Spread of Fire Protection for Large Roofs

Vegetative roofing systems shall be installed in sections not exceeding 15,625 ft² (1,451.6 m²), with each section having no dimension greater than 125 ft. (38.1 m). An *area divider*, as described in Section 3.5 shall be installed to isolate sections of *vegetative roofing systems*. See Commentary C4.3.

4.4 Spread of Fire Protection for combustible features that are part of the vegetative roofing system design, but not part of the building structure

An *area divider* shall be installed around features constructed of *combustible materials* 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.

4.6 Firebreaks

Firebreaks (See Section 3.4) are required where *vegetative roofing systems* abut vertical surfaces constructed of *combustible materials* 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 in. (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.
- ▶ Intensive green roofs are installed with more than 6 in. (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 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 extensive and intensive green roof installations.

Vegetative roofing systems consist 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 roofing system* may consist of more than just *growing media* and vegetation, but include such things as walkways, water features, stone decoration, and benches.

A *vegetative roofing system* 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 *registered design professionals* may have requirements that exceed the minimum requirements outlined in this standard.

While this standard is intended as a reference, the design responsibility rests with the *registered design professional*.

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- μ m (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 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*.

C2.12 Vegetative Roofing System

A *vegetative roofing system* consists of vegetation, *growing media*, a drainage system, and waterproofing over a 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
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 Reinforced Waterproofing System	ASTM D6622

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 roofing system* 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.

C3.3 Slope

The roof should be sloped to shed water effectively or provide a minimum slope requirement, e.g., ¼ in.

C3.6 Border Zones

Border zone dimensions may not always dictate the dimensions of areas that must be free from vegetation, such as at roof perimeters, corners, and other special conditions or building features impacted by wind uplift. ANSI/SPRI RP-14 provides guidance on determining those dimensions and should be compared to the *border zone* requirements of this standard, using the most conservative design.

C3.7 Other Design Considerations

While outside the scope of this standard, the following design considerations must be considered by the *registered design professional* and comply with all requirements of 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.

Wind Design

See *ANSI/SPRI RP-14 Wind Design Standard for Vegetative Roof Systems*.

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 *area dividers* consisting of ASTM E108 or UL 790 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 material* 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), which 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 states 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 *growing media* thickness no less than 1.18 in. (30 mm)
- ▶ made of vegetation that is grasses, succulents and/or perennials
- ▶ have a substrate with at least 80% inorganic content by mass

The agreed minimum *growing media* thickness varies between 1.18 to 3.15 in. (30 to 80 mm).

C4.4 Spread of Fire

The intent of this Section is to provide protection for combustible *vegetative roofing systems*. 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.

References

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5. *ANSI/SPRI RP-14 Wind Design Standard for Vegetative Roof Systems*, SPRI, Waltham, MA July 2022.
6. *Green Roof Plants and Growing Media course manual*; Green Roofs for Healthy Cities.
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8. *ASTM E108 Standard Test Methods for Fire Tests of Roof Coverings*.

Documentation

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