

Purpose

To provide general guidance on the design and construction of roof assemblies on buildings in wildfire zones. Guidance pertains to both new and existing buildings.

Key Issues

- Roof assemblies are the most vulnerable component of the building envelope in a wildfire because of their horizontal orientation and size.
- Embers and firebrands can ignite the roof covering, other roof components, and debris on the roof. Once the roof has ignited, the fire commonly propagates into the interior of the building, resulting in substantial damage to or total loss of the building.
- The probability that a home will survive a wildfire is greatly influenced by the components of the roof assembly. The type and arrangement of the components govern their potential for ignition and their propensity to transfer heat into the interior of the building.
- The complexity of the roof's shape also influences the potential for ignition. A roof with valleys and roof/wall intersections where combustible debris such as leaves and needles can collect has more potential for ignition than a roof without them.

Roof covering: The exterior roof cover or skin of the roof assembly (e.g., shingles, tiles, slate, metal panels, roof membrane).

Roof assembly: An assembly of interacting roof components, including the roof deck, vapor retarder (if present), insulation (if present), insulation cover boards (if present), and the roof covering.

Fire-rated Roof Assemblies

The resistance of roof assemblies to external fire is rated by the American Society of Testing and Materials (ASTM), using test method E108. The method includes measurements of the surface spread of flame, the ability of the roof assembly to resist fire penetration from the exterior of the building to the underside of the roof deck, and the potential for the roof covering to develop flying brands of burning material. Roof assemblies are rated Class A (highest rating), B, or C. Assemblies that fail the test (do not meet the Class A, B, or C criteria) are unrated.

ASTM E 108 test conditions do not replicate actual wildfire conditions. In many cases, actual wildfire exposures are much more severe than those induced during the testing.

Class A provides the greatest degree of fire resistance, but there is a range of protection within the Class A rating. For example, some Class A rated assemblies have noncombustible roof

coverings (such as clay or concrete tiles and metal panels), while others have combustible coverings (such as asphalt shingles and low-slope membranes).

Guidance for New Buildings

Many types of roof assemblies are rated Class A. Recommendations for various components of roof assemblies that are rated Class A are provided below.

Only Class A rated roof assemblies are recommended for homes in wildfire zones.

Steep-slope Roof: Covering

A steep-slope roof is a roof with a slope greater than 3:12. The following design and installation practices are recommended:

- **Tile.** Clay and concrete tile are noncombustible and because of their relatively large thermal mass, retard the transfer of heat. Lightweight tile products are available, but normal-weight tiles are recommended because of their greater mass. If tiles are installed over wood battens, embers may be blown under the tiles and ignite the battens. Fire-retardant-treated battens are therefore recommended. If tile is used, the following are also recommended:
 - **Eaves, hips, and ridges.** Embers can be blown under tiles at the eaves, hips, and ridges. Birds can build nests in the space between the underlayment and the bottom of the tiles if the space is accessible, providing combustible debris that can be ignited by embers. Installing birdstops at eaves and fully mortaring hips and ridges are both recommended to avoid the accumulation of debris under tiles and to keep embers out (see Figure 1).
 - **Valleys.** Unless special metal flashing is installed, combustible debris can accumulate in valleys and then under the tiles. Flat and plain tiles should be specified to be tightly butted to form a closed valley, and pieces of metal flashing should be installed under each tile course along the valley centerline. For profiled tile, lead or flexible flashing should be used, as recommended by the tile manufacturer (see Figure 2).
- **Metal shingles and panels.** Metal shingles and panels are noncombustible, but they readily transfer heat. If they are installed over wood battens, fire-retardant-treated battens should be specified and installed. If shingles or panels are installed over wood decking, 5/8-inch gypsum



Figure 1. A birdstop at the eave.

roof board complying with ASTM C 1177¹ should be installed over the decking.

- **Fiberglass-reinforced asphalt shingles.** Although a roof assembly that has fiberglass-reinforced asphalt shingles can be rated as Class A, these shingles contain combustible material (e.g., asphalt). If this type of shingle is used, a 5/8-inch gypsum roof board that complies with ASTM C 1177 over the wood decking should be installed for enhanced protection of the decking. Care needs to be taken when the shingles are nailed that the nails are not overdriven.
- **Wood shingles and shakes.** Roof assemblies that have wood shingles and shakes can be rated Class A if the shingles or shakes are fire-retardant-treated and a specific cap sheet underlayment is installed. Without the underlayment, the maximum rating is Class B. Note that when shingles or shakes are fire-retardant-treated, they cannot be impregnated with preservative treatment.

If fire-retardant-treated shingles or shakes are installed over wood decking, installing a 5/8-inch gypsum roof board that complies with ASTM C 1177 over the decking is recommended in addition to the special underlayment that is required to achieve a Class A rating.



Figure 2. Special valley flashing to avoid debris accumulation between and below tiles (photograph courtesy of MonierLifetile).

Steep-slope Roof: Underlayment

Embers can be blown under some types of steep-slope coverings such as tile, slate, and metal shingles and panels. If tiles become dislodged or cracked, embers can land on the underlayment below (see Figure 3). Installing an underlayment that has enhanced fire resistance is recommended to provide protection from embers that reach the underlayment.

An example of an enhanced underlayment is a mineral-surface cap sheet that is rated for use in a Class A rated assembly.² If a mineral-surface cap sheet is used under metal panels or shingles, measures should be taken to prevent the metal from bearing directly on the cap sheet and the cap sheet from abrading the metal (thereby making the metal susceptible to corrosion).



Figure 3. Displaced tiles allow ember entry.

¹ Boards that are 5/8-inch thick are type X (“special fire-resistant”). Boards that are 1/2-inch and 1/4-inch thick are not type X.

² Although cap sheets are normally the finished surface of a built-up or modified bituminous roof covering, a cap sheet can also be used as an underlayment.

Steep-slope Roof: Decking

Most homes have roof decks that are constructed of wood, typically plywood or oriented strand board. Fire-retardant-treated decking can be specified to avoid ignition of the deck. For more protection, 5/8-inch gypsum roof boards can be specified in addition to the fire-retardant-treated deck.

Although not common in homes, noncombustible decks such as steel or concrete, including concrete topping over steel decking, can be specified. In addition to being noncombustible, concrete decks offer great resistance to heat transfer and fire penetration through the deck from the exterior.

Low-slope Roof: Covering and Underlayment

Low-slope roofs have slopes less than 3:12.

A variety of low-slope roof coverings and assemblies are available with a Class A rating.

If a low-slope assembly is selected, the following recommendations should be followed:

- Polyisocyanurate roof insulation should be specified (see Figure 4).
- A 5/8-inch gypsum roof board that complies with ASTM C 1177 immediately below the roof membrane (see Figure 4) should be specified.
- For enhanced fire resistance, in addition to the above recommendations, the roof membrane should be protected with heavyweight (i.e., 17 pounds per square foot minimum) concrete pavers (see Figure 5).
 - If pavers are placed over a built-up or modified bitumen membrane, a layer of extruded polystyrene insulation (intended for protected membrane systems) over the membrane should be specified.

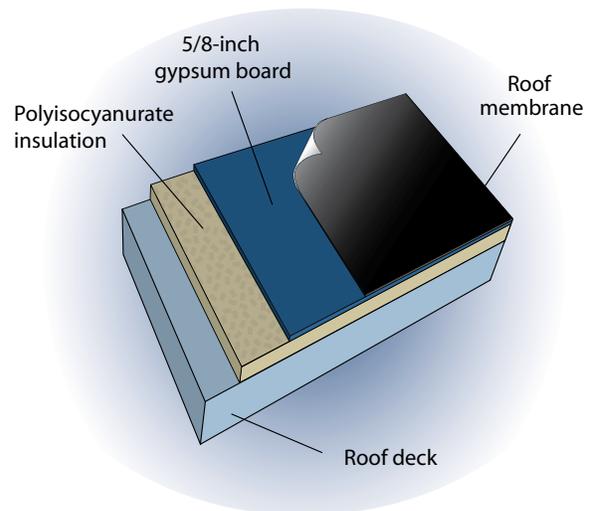


Figure 4. Components of a low-sloped roof.

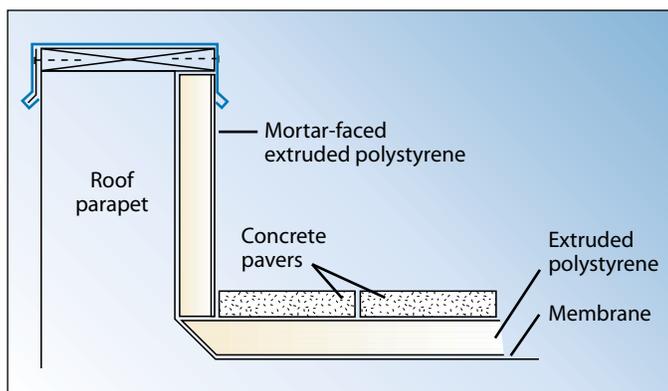


Figure 5. Concrete pavers over membrane (FEMA 55).

- Additionally, for smooth-surfaced built-up and modified bitumen membranes, a sheet of polyethylene (minimum of 4 mils) should be specified between the membrane and polystyrene to keep the polystyrene from bonding to the membrane.
- To protect the base flashings, a mortar-faced extruded polystyrene board should be installed over the base flashing (see Figure 5).

Low-slope Roof: Decking

Roof decking design and construction are the same for steep-slope and low-slope roofs. See the discussion under steep-slope roofs above.

Guidance for Existing Buildings

For homeowners with roof assemblies that are not Class A rated, the only long-term, reliable way to reduce roof vulnerability to wildfire is to reroof. Reroofing normally involves removing the materials above the roof deck and replacing them with new materials. The recommendations that are listed above for new buildings are applicable to reroofing design and installation.

Roof assemblies that have wood shingles or shakes and are not rated Class A and roofs with organic-reinforced asphalt shingles are vulnerable to a wildfire. These types of roofs should be replaced as soon as possible.

Considerations

- The homeowner should have roof debris removed from the roof surface and gutters regularly.
- Aging does not affect the ignition potential of tile. However, some roof coverings, such as wood or fiberglass-reinforced asphalt shingles, become more susceptible to ignition as they age. The roof covering should be replaced before deterioration of the covering significantly degrades resistance to ignition.
- Birdstops should be inspected annually to ensure that they have not fallen out of place.
- For recommendations on vents, see Fact Sheet #8, Vents.
- For recommendations on gutters and downspouts, see Fact Sheet #9, Gutters and Downspouts.

Effectiveness

All mitigation measures recommended in this Fact Sheet are effective in all Fire Severity Zones.

Resources

American Society of Testing Materials (ASTM). 2007. *Standard Test Methods for Fire Tests of Roof Coverings*. ASTM E108-07a.

FEMA. 2003. *Coastal Construction Manual*. FEMA 55.

