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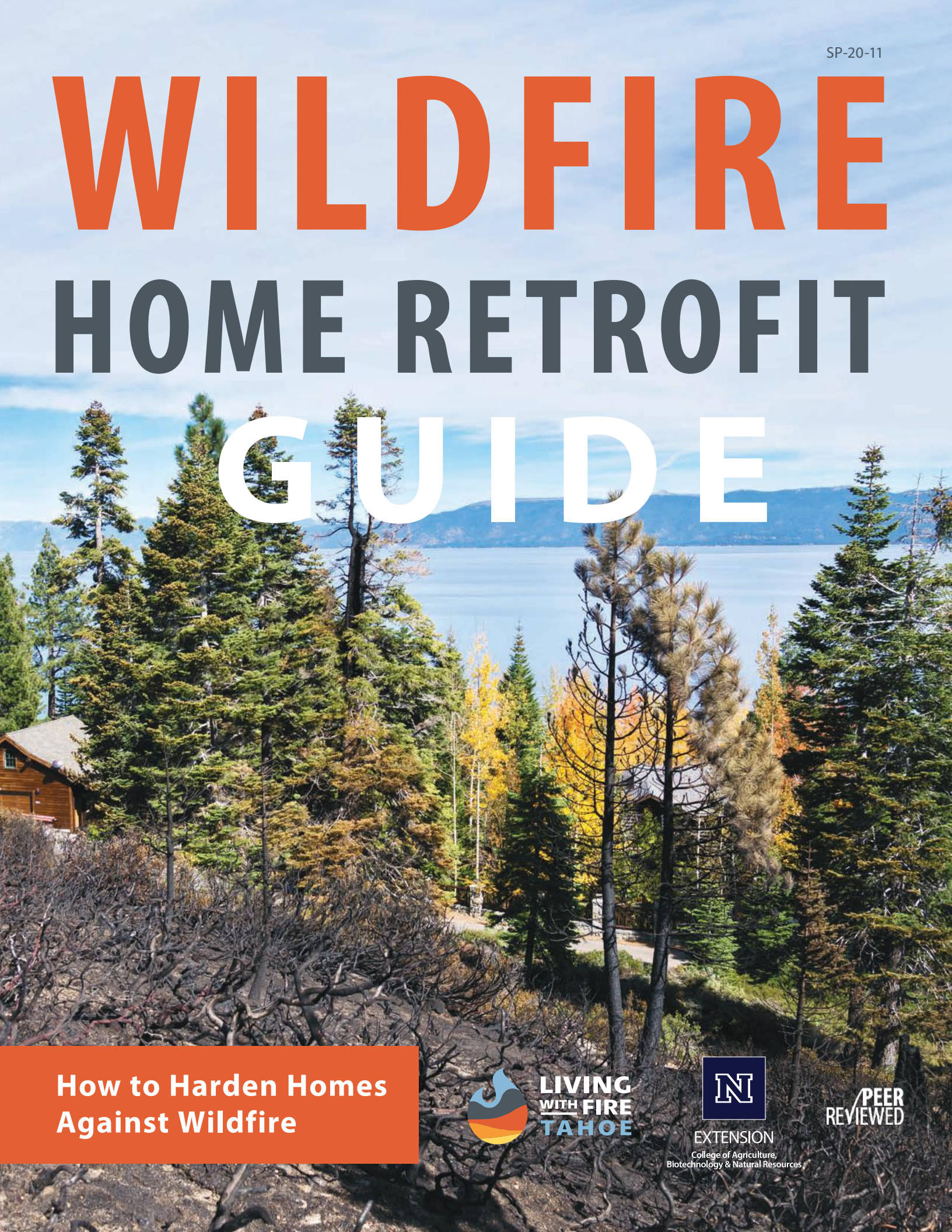
WILDFIRE HOME RETROFIT GUIDE



How to Harden Homes Against Wildfire

LIVING WITH FIRE TAHOE

EXTENSION
College of Agriculture, Biotechnology & Natural Resources

PEER REVIEWED

How to Use This Guide

This Guide includes specific recommendations for how to retrofit existing components of a home to withstand wildfire. Each section contains an explanation of how the component is vulnerable to wildfire and what can be done to improve that component. The illustrations throughout the Guide are intended to show best practices for reducing the vulnerability of a home to wildfire.

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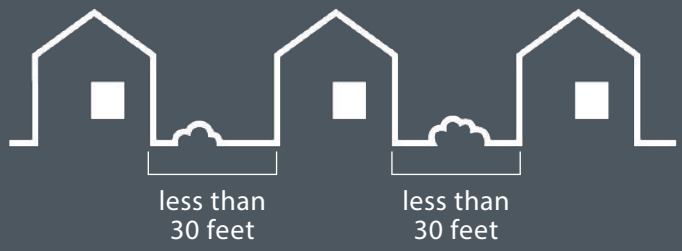
When using this Guide, think about the location and context of the home and how that influences vulnerability to wildfire:

Steep Slopes

When homes are located on steep slopes, decks commonly overhang the slope below, and this downslope area is often heavily vegetated. Prioritize defensible space actions so that flames from burning vegetation cannot reach the underside of the deck and ignite, with subsequent ignition of the home.



Dense Neighborhoods

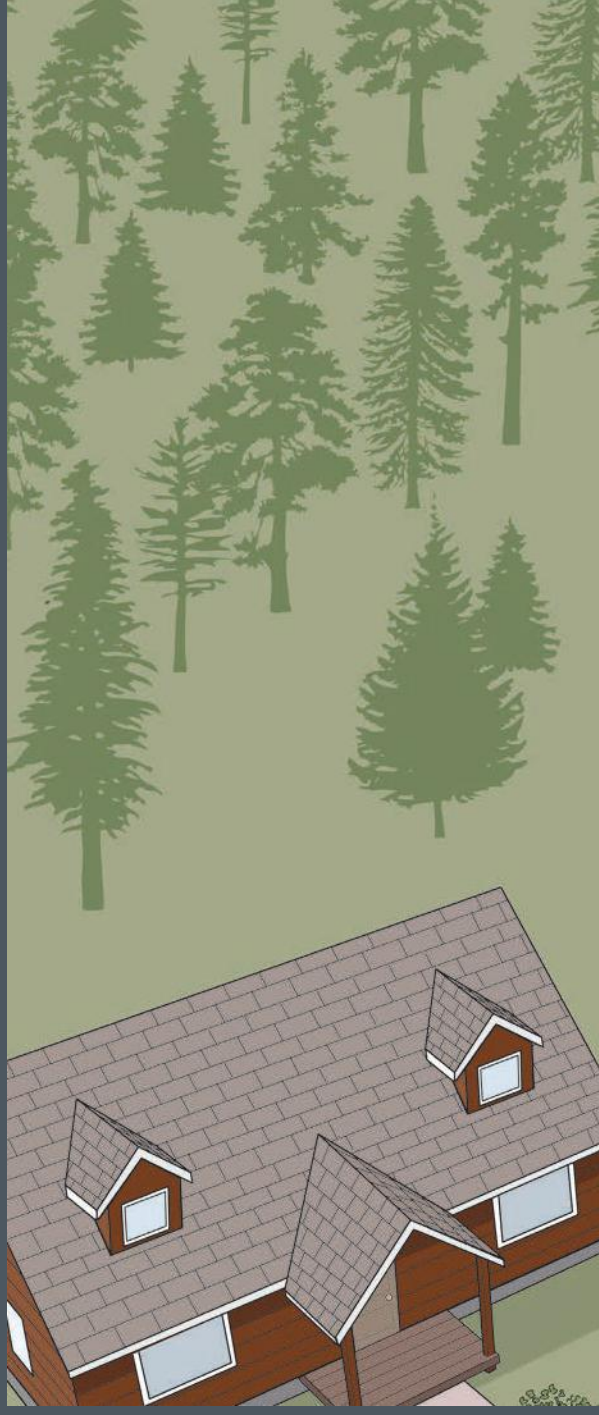
Dense neighborhoods with homes close together have an increased risk of building to building ignition because of the radiated heat and potential flames that are generated if a neighbor's home burns. Prioritize actions to reduce the possibility of homes igniting each other. Intensify defensible space by thinning trees and shrubs between homes. Engage in neighborhood conversations to encourage all neighbors to take actions to reduce their own vulnerability to wildfire.

Large-Parcel Lots

When homes are on large parcel lots and neighboring homes are far apart, vegetation and other combustible materials on the property (e.g., wood pile, tool shed) can be a large factor in home ignition. Prioritize creating and maintaining defensible space, including the near-home noncombustible zone, and home-hardening techniques to reduce vulnerability from embers.

Living within the natural environment brings both serenity and responsibility.

Communities located in wildfire-prone areas need to take extra measures to live safely. There are many ways to prepare communities and properties for wildfire, including creating and maintaining adequate defensible space and hardening homes through altering or replacing the construction components. This guide will help residents and building professionals better understand how to prepare homes and communities for wildfire.

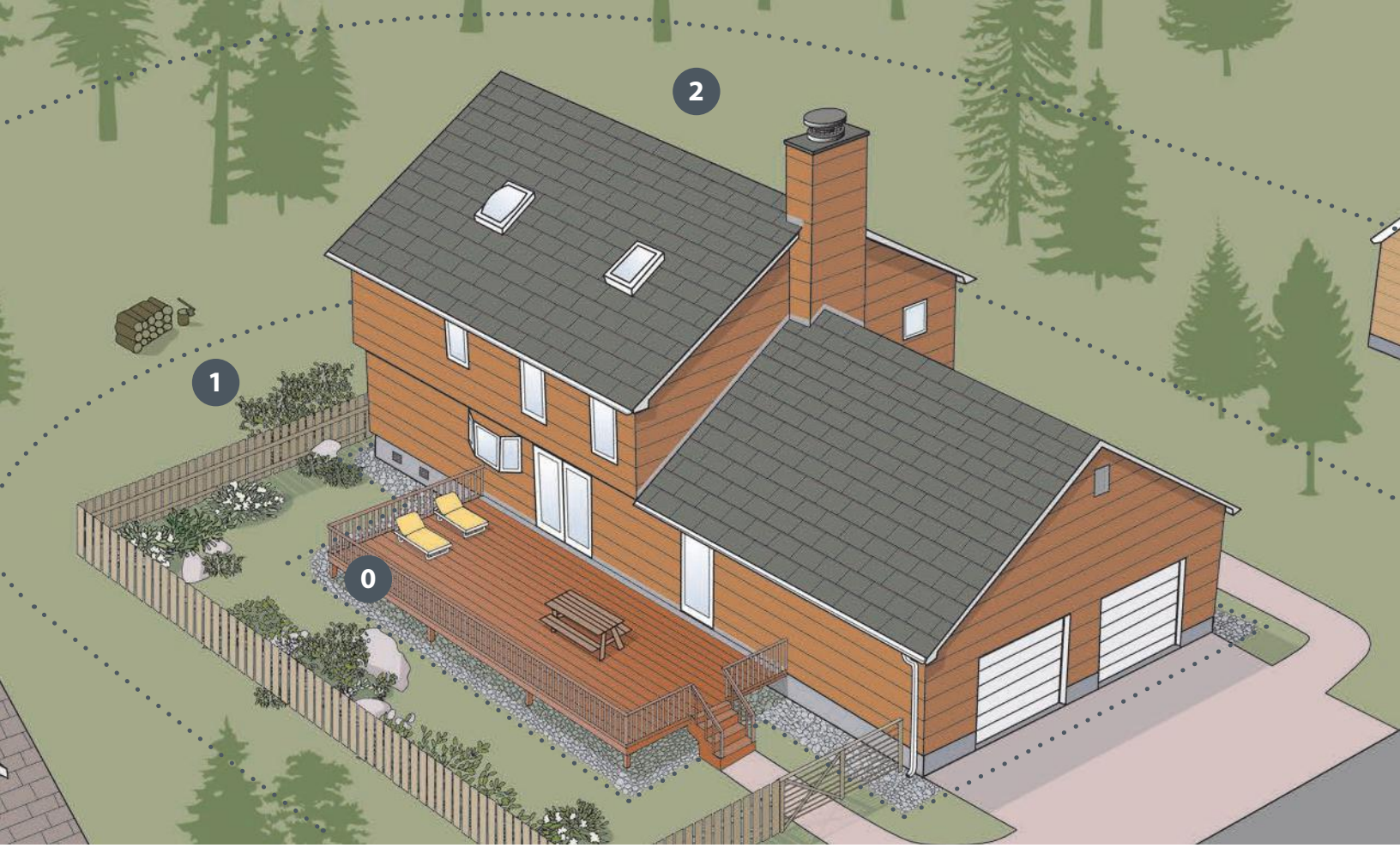


DURING A WILDFIRE, homes can be threatened by **1)** wind-blown embers, **2)** radiant heat, and **3)** direct flame contact.

In wildfire events, 60-90% of home loss is due to embers. Embers can originate from an approaching wildfire or small parts of nearby burning vegetation and construc tion materials (e.g., a home, storage shed, wood pile). Embers are important because of what they can do directly (e.g., ignite materials in an attic after entering through a vent) and what they can do

indirectly (e.g., ignite a wood pile or storage shed located close to the home, resulting in radiant heat or direct flame contact to the side of the home). Reducing the vulnerability of homes to ember ignition will increase the chance of homes and neighborhoods surviving a wildfire.

The most effective way for homes to withstand wildfire is a "coupled approach" that considers the exterior construction materials and how they are put together, as well as the surrounding vegetation and other near-home combustible materials. Selection, location and maintenance of vegetation and other combustible materials on a property can reduce the chance of a wildfire burning the home. This Guide provides information and recommendations for retrofitting an existing or newly constructed home with wildfire in mind.



Protecting a home from wildfire requires continual defensible space actions in three zones around the property.

Defensible Space

0 **THE EMBER-RESISTANT ZONE (Zone 0) | 0–5 feet**: The zone within 5 feet of your home has many different names (e.g., the noncombustible zone, the immediate zone, the zero zone), but the objective is generally the same—to reduce the vulnerability of the home to embers by creating a zone of ember-resistant materials around the home. Gravel, a concrete or brick walkway, or another hardscape feature is commonly used to construct this zone. This ember-resistant zone should include the area under and around any attached deck. Be sure to keep this zone clean of any woodpiles, wood mulch, or flammable vegetation.

1 **THE LEAN, CLEAN AND GREEN ZONE (Zone 1) | 5–30 feet**: The objective of this zone is to reduce the risk of fire spreading from surrounding vegetation to the home. Lean indicates that there is only a small amount of vegetation, if any, present. Vegetation should be grouped in discontinuous islands. Clean indicates that vegetative debris and dead materials are routinely removed. Green indicates that vegetation within this zone is kept green and well irrigated (if appropriate) during the fire season.

Contact local Extension offices for more information about defensible space recommendations specific to different regions.

2 **THE REDUCED FUEL ZONE (Zone 2) | 30–100 feet**: The objective of this zone is to reduce fire spread and restrict fire movement into the crowns of trees or shrubs. Remove dead plant material, lower tree branches and other ladder fuels (e.g., shrubs, lower branches, smaller trees). Locate outbuildings (e.g., for storage) at least 30 feet away from the home and create an ember-resistant zone around all outbuildings and propane tanks.

Roofs

Making a roof "fire-safe" is a big step in reducing the vulnerability of the home to wildfire. There are three fire ratings for roof coverings: Class A, Class B and Class C, with Class A providing the greatest fire protection. The roof rating designation provides information for the roof covering material and does not include where the roof meets other materials at the edge of the roof. A non-fire-retardant treated wood shake or shingle roof covering is unrated and is not desirable—these roof types have less than a Class C rating.

HOW TO REDUCE THE VULNERABILITY OF ROOFS

- Replace a wood shake or shingle roof with a Class A roof.
- Remove accumulated vegetative debris from the roof.
- If there is a space between the roofing materials and roof deck, make sure that the openings between the covering and the roof deck are blocked. Repair areas as needed.
- If the roof consists of Class B or C roofing materials, determine if the underlayment in the assembly provides Class A protection as indicated in manufacturer installation instructions. When viewed from the edge of the roof, these materials would either look like gypsum wallboard or overlapping 4-foot wide sections of an asphalt composition roof covering. Maintain the roof covering and replace with a Class A product when needed.

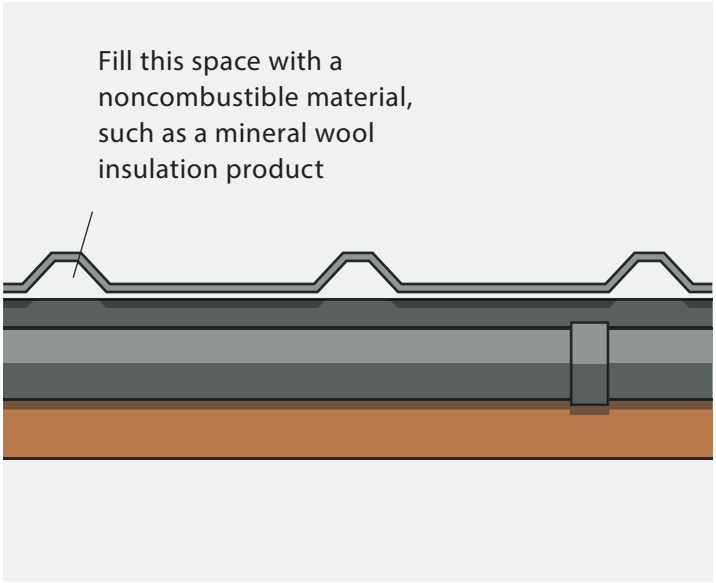
A CLASS A ROOFING materials include asphalt fiberglass composition shingles, clay and cementitious tiles (both flat and barrel shaped), and some metal roofing materials.

B CLASS B ROOFING materials are most commonly exterior-rated, pressure-impregnated fire-retardant treated shake or shingle covering (not allowed for use in many jurisdictions).

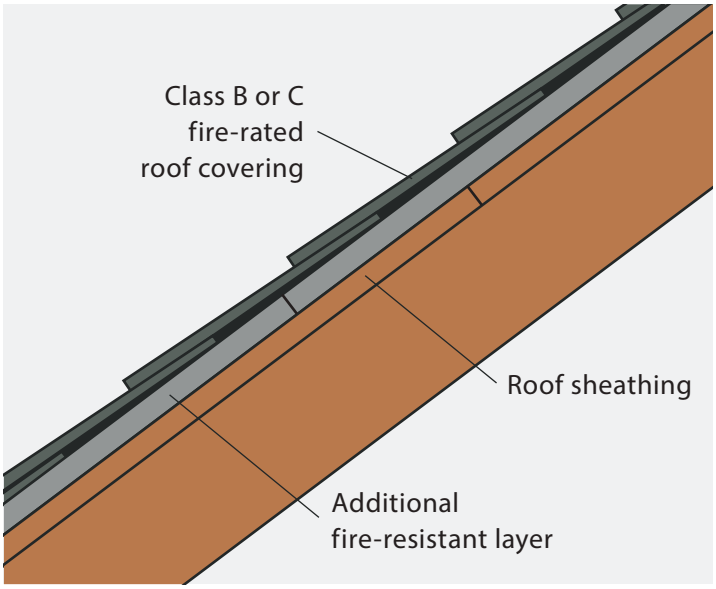
C CLASS C ROOFING materials include recycled plastic, rubber and aluminum.

Class B and Class C roofing materials can have a Class A "by assembly" rating. In these cases, additional materials that enhance the fire resistance of the roof assembly (i.e., the roofing material plus other materials included in the roof assembly) must be installed. In these cases, be sure to follow the manufacturer's instructions.

METAL ROOF



CLASS A "BY ASSEMBLY" FIRE-RATED ROOF COVERING

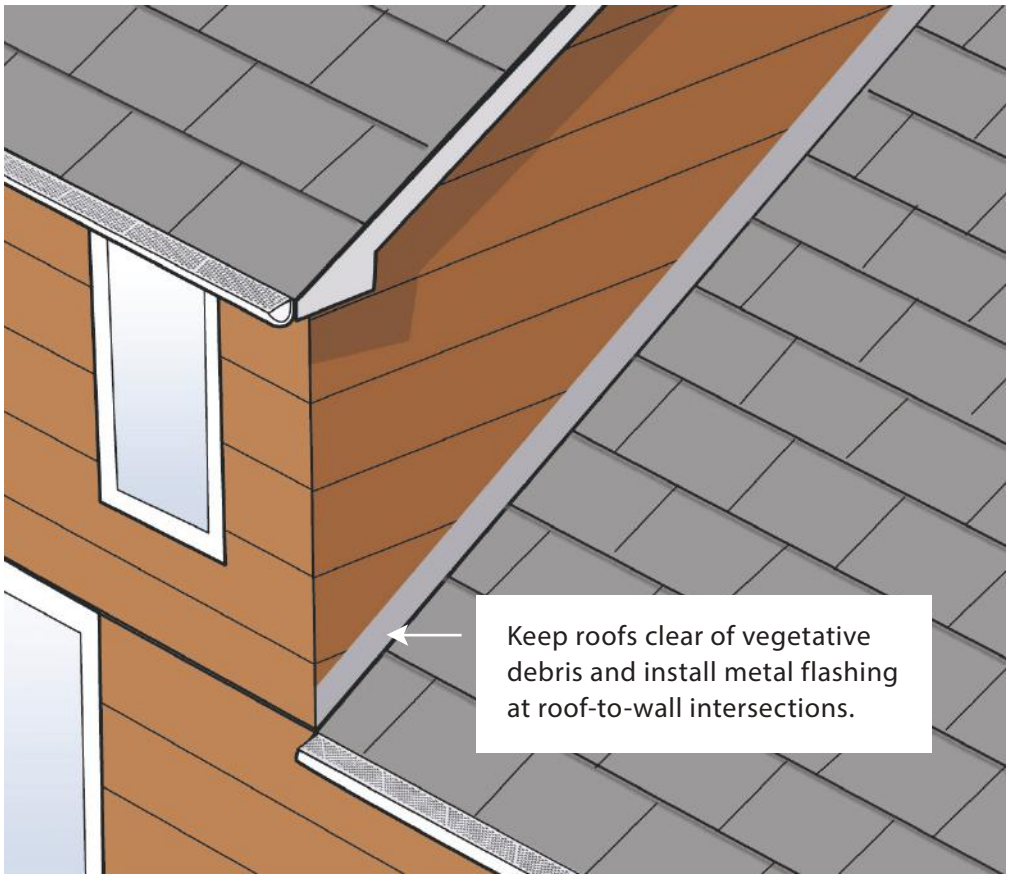


Roof Edges

There can be several areas where the roof meets another material, such as at a roof-to-wall intersection in a split-level home or a dormer on a roof. These intersections are vulnerable areas because wind-blown embers will gather at the same locations where vegetative debris has accumulated, igniting the debris. Building materials usually change at edge-of-roof locations. The adjacent materials should provide comparable protection to the roofing material.

HOW TO REDUCE THE VULNERABILITY OF ROOF EDGES

- Remove accumulated vegetative debris from roofs on a regular basis.
- Replace the combustible siding in roof-to-wall locations with a noncombustible option. Replacement of siding only in these locations will be less expensive than replacing all the home's siding. It may be possible to find a noncombustible siding pattern that is similar to the existing siding pattern.
- At a roof-to-siding location, use of metal flashing that extends up the siding at least 6-inches could also reduce the vulnerability of a combustible siding material. Install flashing so that water cannot get between flashing and siding.

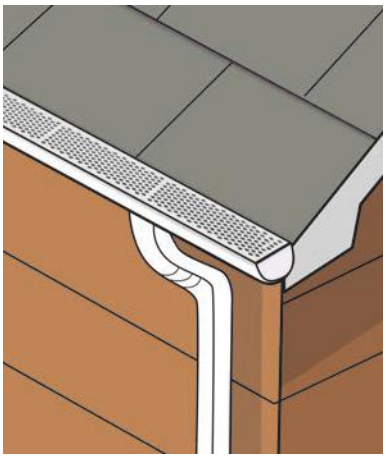


Rain Gutters

Roofs can be vulnerable at the roof edge where a gutter is attached. Debris in the gutter can ignite from embers, and flames can ignite other components at the roof edge (e.g., wood-based sheathing and fascia board).

HOW TO REDUCE THE VULNERABILITY OF RAIN GUTTERS

- Remove vegetative debris from gutters on a regular basis during fire season.
- Install a noncombustible and corrosion-resistant metal drip edge to provide protection for the combustible components (i.e., sheathing and fascia) at the edge of your roof.
- Use a noncombustible gutter cover to minimize accumulation of debris in the gutter. Some gutter covers result in accumulation of debris on the roof behind the gutter, so these will still require routine maintenance.



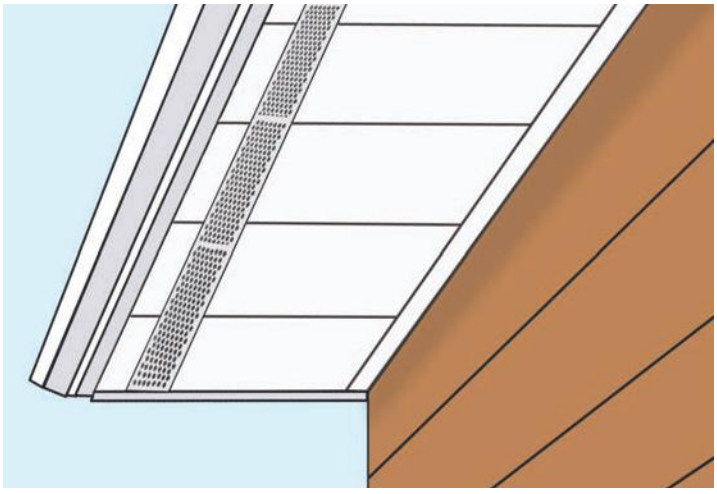
Install and maintain a noncombustible gutter cover (as pictured above) to help minimize debris accumulation in gutters.

Eaves

The under-eave area provides a point of entry for flames if nearby vegetation or other materials are burning. There are two basic designs for under-eave construction: open-eave and soffited-eave (i.e., one that is boxed in). Open-eave designs are more vulnerable to flames—heat can build up in an area between the roof rafters allowing for more rapid fire spread laterally, which increases the likelihood that fire will find a location to enter the attic. Vents that are in the blocking between rafters in open-eave construction are more vulnerable to the entry of embers than vents in a soffited-eave.

OPEN EAVE

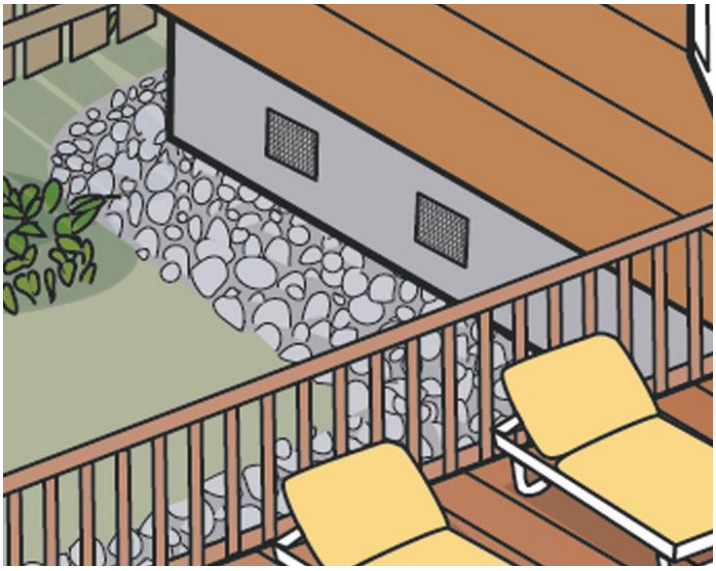
SOFFITED EAVE

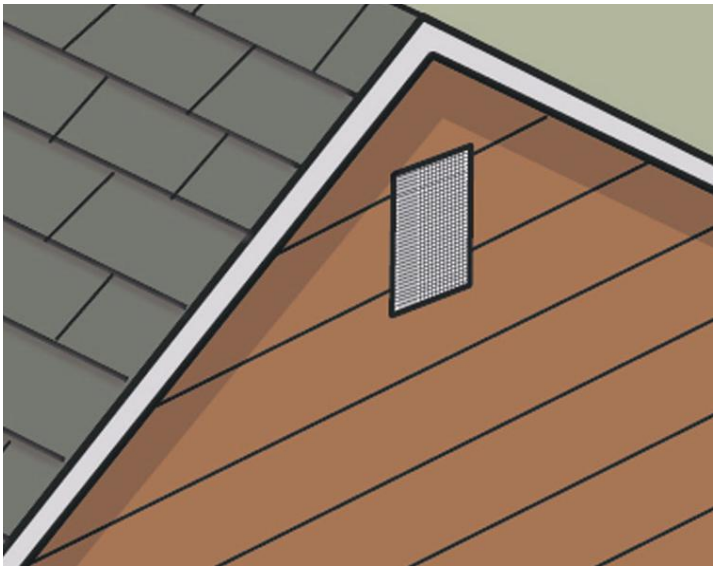


Enclose open eaves to protect attic spaces from ember intrusion.

HOW TO REDUCE THE VULNERABILITY OF EAVES

- Inspect open-eave areas for gaps where embers could lodge or pass through into the attic. All vents should be screened and all other gaps should be filled with durable caulk.
- Enclose under-eave area to create a soffited eave.





Cover all vents with ⅛-inch mesh screening.

WHAT IS THE DIFFERENCE BETWEEN VENT SCREEN SIZES?

Small screens (1/16-inch) can reduce both the size and number of embers that can pass through. Because the embers are smaller, they self-extinguish quickly after entering the attic and crawl space. While this screen size is ideal for resisting ember intrusion, it does require more maintenance because it gets easily clogged. Accumulated debris on vents can become a source of embers if not cleaned regularly. Air flow is also reduced with this size screen.

Mid-size screens (⅛-inch) allow more, larger embers to enter the attic and crawl space, but these are still better than 1/4-inch screens. This size screen is a common choice because the maintentance is lower while still being relatively effective.

Large screens (¼-inch) allow many, larger embers to enter the attic and crawl sapace. It is recommended you replace or cover 1/4-inch screeens with a smaller grain.

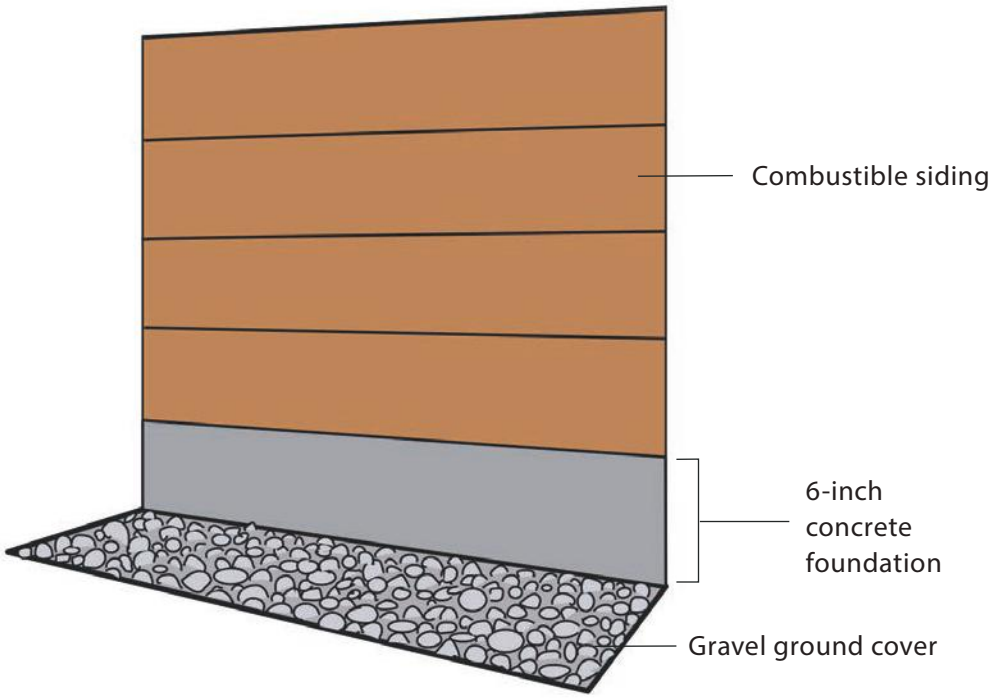
Vents

Attic and crawl space vents provide an entry point for embers. Vents should be covered by, at a minimum, ⅛-inch noncombustible corrosion-resistant metal mesh screening. Screening will not prevent the intrusion of all embers but will minimize their size. Finer mesh screening (e.g., 1/16-inch mesh) is more effective at keeping embers out of the home but requires more maintenance because it can become clogged with debris. Vents that meet the flame- and ember-resistant standard are listed on the California Office of the State Fire Marshal Building Materials Listing Program website. These types of vents are appropriate in areas where maintaining defensible space is difficult, combustible materials are closer to the home, or combustible siding is used.

HOW TO REDUCE THE VULNERABILITY OF ATTIC AND CRAWL SPACES

- Avoid storing combustible items (e.g., cardboard boxes, newspapers and magazines) near attic or crawl space vents.
- Inspect vents to make sure they are in good condition (i.e., screen is in good condition with no tears that would result in larger openings).
- If ¼-inch mesh screening is present, replace or add, at a minimum, a ⅛-inch noncombustible corrosion resistant metal mesh screen.
- Consider replacing vents with a flame- and ember-resistant option.

Vent covers that are made ahead of time (i.e., before a wildfire is threatening) can be installed when wildfire is threatening the area. This strategy can be effective, but it does take time and should only be undertaken if ample time is given for evacuation. Preparation activities can be dangerous if evacuation is delayed.



Siding

If the siding ignites, a fire can: **1)** penetrate through the stud cavity into the home, **2)** spread up the side of the home and enter windows or other openings such as dryer vents, and **3)** spread into the attic at a gable-end vent or an under-eave area. Combustible siding can be ignited from direct-flame contact or radiant heat exposure. Ignition of siding from embers can occur, especially if embers ignite combustible materials close to the home (e.g., bark mulch or wood pile), and if siding extends all the way to the ground.

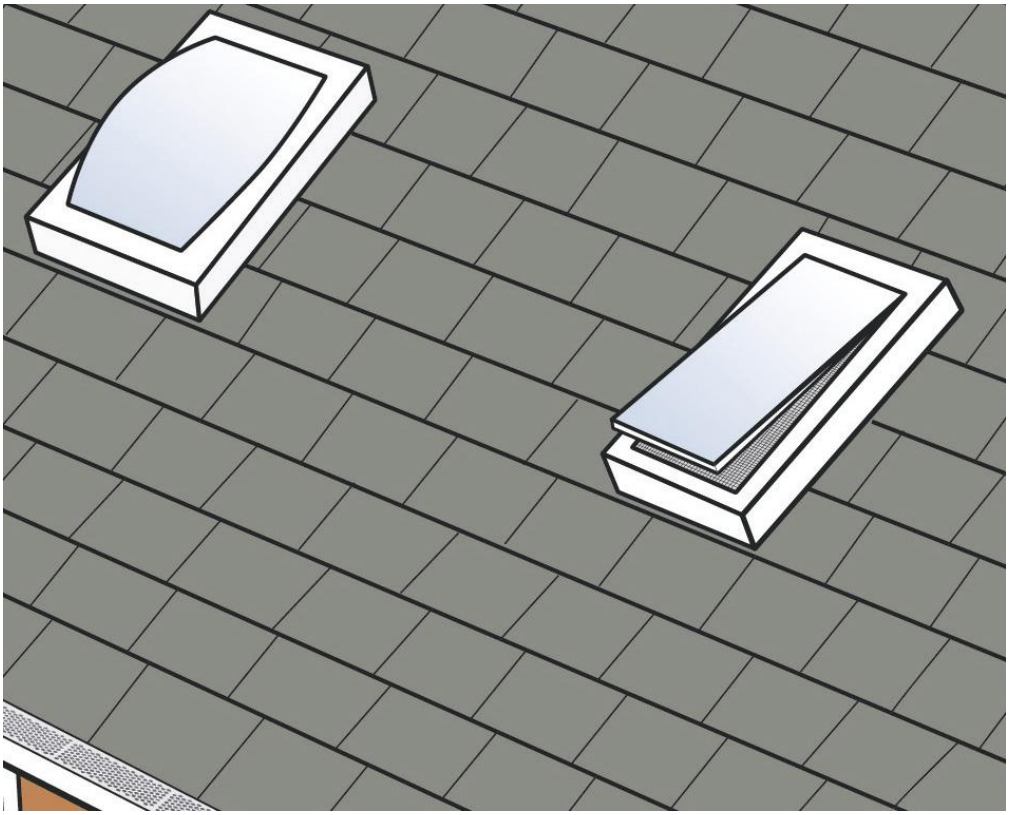
Combustible siding products are widely used, including solid wood, wood composite materials and plastic/vinyl products. Vinyl siding can deform and slough off when exposed to flames or radiant heat. Once this happens, underlying material (e.g., sheathing) becomes important for protection. More complicated lap joints in wood-based siding patterns (e.g., shiplap and tongue-and-groove) are more resistant to fire penetration at the lap joint. Plain bevel joints in wood siding are vulnerable to fire penetration. While fiber cement siding often uses a plain bevel lap joint, it is less vulnerable to fire penetration.

HOW TO REDUCE THE VULNERABILITY OF SIDING

- Use noncombustible siding (e.g., stucco, steel and fiber cement), especially when neighboring homes are within 30-feet of the home.
- Make sure to develop and maintain adequate defensible space, particularly within the ember-resistant zone, to minimize the chance that siding will ignite from embers at the ground level or direct-flame contact from nearby combustible materials.
- In smaller areas that are vulnerable, such as at a roof-to-wall area, replace siding with a noncombustible product.
- For new construction, use of a one-hour wall design, where an additional fire resistant layer is used in the wall assembly, can provide additional protection when a more vulnerable siding material is used.

It is not recommended to use fire-retardant coatings, such as fire-retardant paint, to provide fire protection for combustible siding. Some state, county and local building codes do not allow these coatings. Recent research has demonstrated that their performance is degraded by exposure to the elements (e.g., snow, moisture, sun). Their effectiveness degrades more quickly than reported.

Clear debris around skylights and make sure to close before evacuating. →



Skylights

Skylights can be a point for ember and flame entry if the cover fails, or if skylights are left open when a wildfire threatens. There are two basic kinds of skylights: domed-style made of plastic and flat-style made of glass. Flat-style, glass skylights have less risk than domed-style, plastic skylights that may melt and burn when exposed to heat from a wildfire. Typically, the glass in skylights consists of two layers, the outer being tempered glass and the inner being a safety glass, such as laminated glass.

Skylights on steeper sloped roofs can be vulnerable to radiant heat and flame contact exposures if nearby combustible materials ignite and burn. Skylights on low-slope (flatter) roofs are more prone to the accumulation of vegetative debris (especially flat-style skylights).

HOW TO REDUCE THE VULNERABILITY OF SKYLIGHTS

- Remove vegetative debris from the roof, including on and adjacent to skylights, on a regular basis.
- On sloped roofs, glass skylights are the best choice because of increased likelihood of exposure to radiant heat.
- If the skylight can open, close it when wildfire is threatening to prevent embers from entering the home. Consider adding a 1/16-inch noncombustible corrosion resistant-metal mesh screening to reduce ember intrusion into the home in case the skylight cannot be closed before evacuation.

Windows

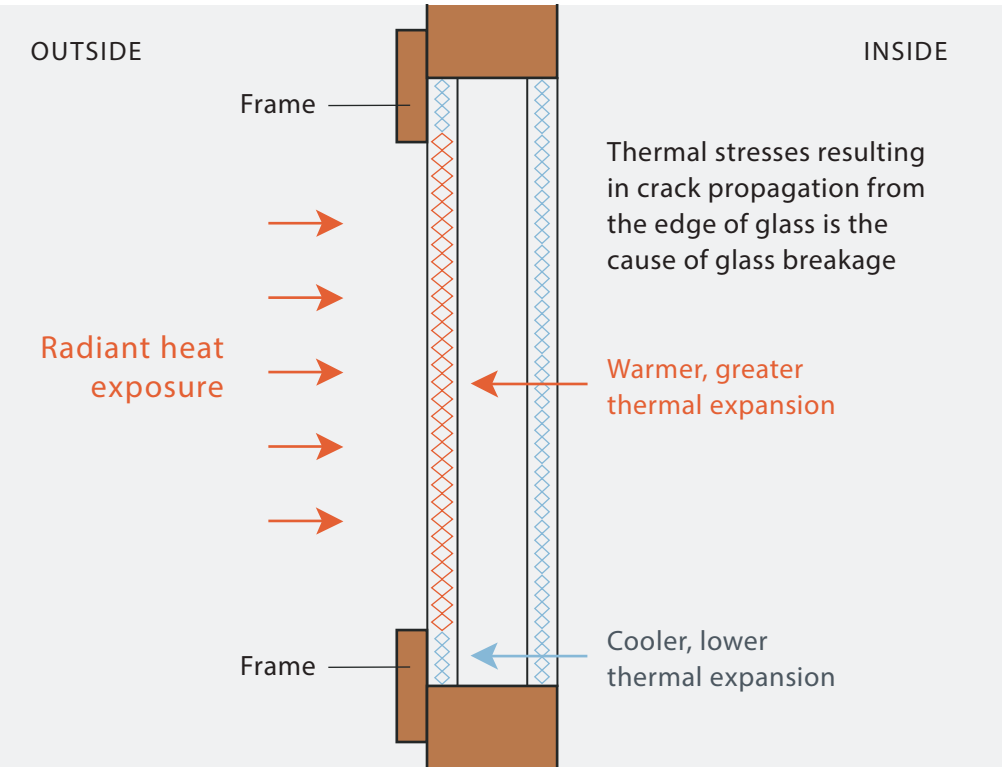
Windows can be a vulnerable component of a home if the framing material ignites or deforms, or if the glass breaks and falls out, both allowing embers or flames to enter the home. The most vulnerable part of a window is the glass. Glass breakage occurs when cracks, propagating from the outer edge inward, occur due to thermal stress that develops when a window is exposed to flames or radiant heat.

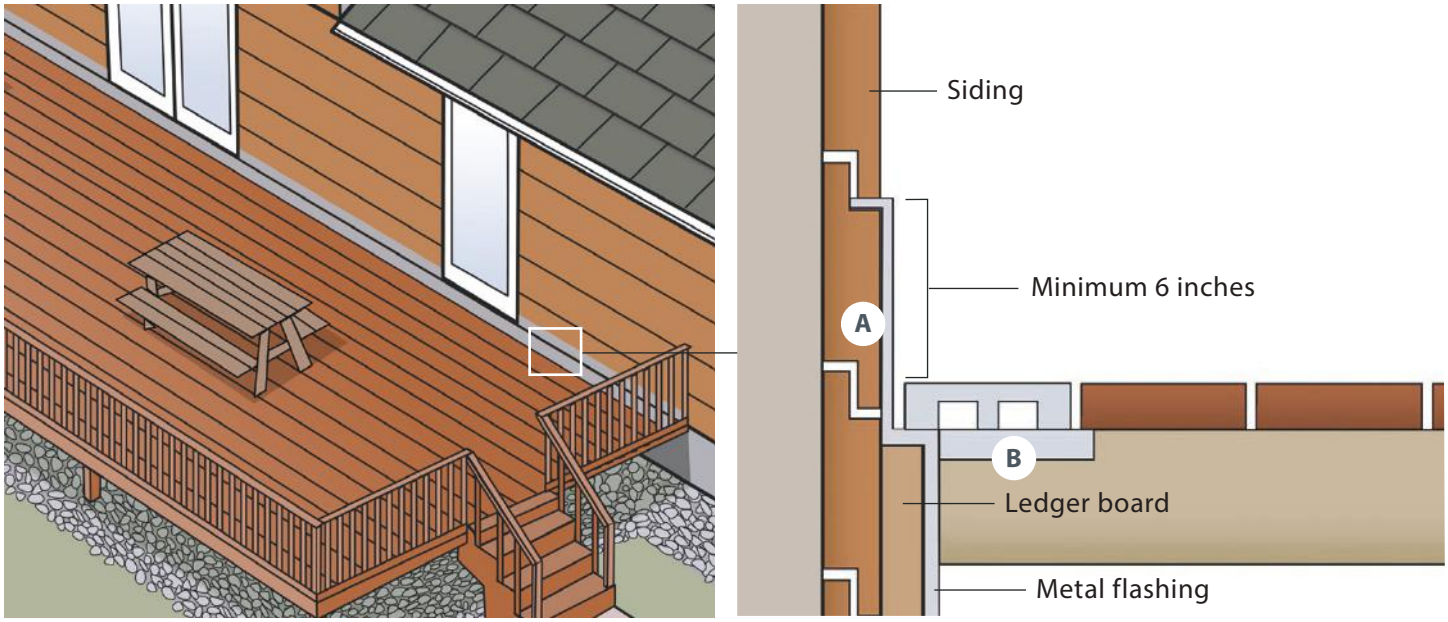
Tempered glass is three to four times more resistant to heat exposures than typical annealed glass and is therefore a better choice when selecting windows. Metal and plastic-clad fiberglass window screening will absorb radiant energy, providing additional protection against radiant heat exposure to the glass in your windows. Plastic-clad fiberglass screening will fail if flames contact it, reinforcing the need for an effective ember-resistant zone.

HOW TO REDUCE THE VULNERABILITY OF WINDOWS

- When replacing windows, choose multi-pane options containing tempered glass.
- If neighbors or outbuildings are within 30-feet of the home, consider installing deployable noncombustible shutters to provide additional protection.
- Install screens in all operable windows. Screens increase ember resistance by keeping embers out of the home and also decrease radiant heat exposure.
- Close windows when wildfire is threatening.

DUAL-PANE WINDOW





A *Install metal flashing between the ledger board and joists to protect the combustible siding material. The flashing should extend above and below the ledger board.*

B *Replace the deckboard next to the house with noncombustible material.*

Decks

If a deck attached to a home ignites, the home can be exposed to flames and/or radiant heat. What is stored underneath and on top of decks can also be an ignition source. Depending on the decking material, embers can also directly ignite deck boards. Decks that overhang a slope can be exposed to flames if trees and other vegetation downslope of the deck ignite, resulting in flames contacting the bottom of the deck.

Most commercially available deck boards are combustible. These include redwood, cedar and tropical hardwoods, such as ipe, and all plastic composite lumber decking products. Pressure impregnated fire retardant treated (FRT) wood deck boards are less vulnerable to flames and embers. Higher density hardwood decking and plastic composite decking are less vulnerable to ignition by embers compared to softwood decking (i.e., redwood and cedar). Although some metal deck boards are now available, noncombustible options are typically referred to as solid surface decks because they consist of lightweight concrete, possibly with an additional noncombustible walking surface such as flagstone. Use of noncombustible (i.e., steel) joists in conjunction with combustible deck boards will reduce the overall vulnerability of the deck.

HOW TO REDUCE THE VULNERABILITY OF DECKS

- Create an ember-resistant zone under the footprint of and around all decks. This action will reduce the likelihood of under-deck flame exposure.
- If a deck overhangs a slope, create and maintain an effective defensible space downslope of the deck to reduce the chance of flames reaching the underside of the deck.
- Apply metal flashing or foil-face bitumen tape on top of and a few inches down the side of the support joists. This is an effective strategy to minimize fire growth when a deck is ignited by embers, but would not help if the deck were ignited directly by flames under the deck. Using steel joists also reduces the vulnerability of the deck from both flames and embers.

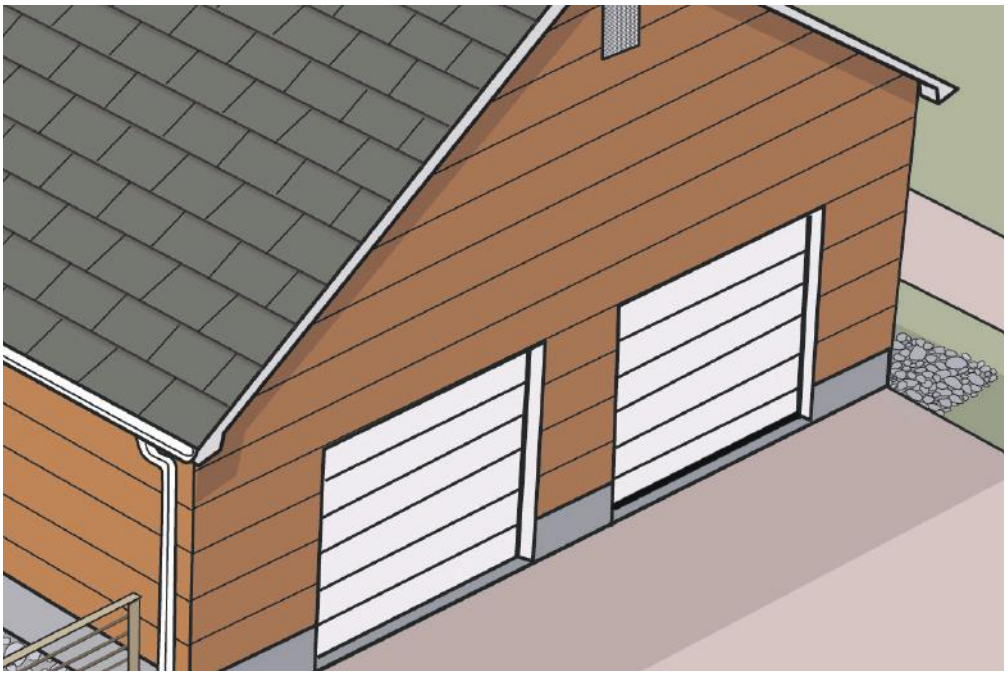
- For cedar and redwood decks, increase the size of the gap between deck boards to ¼ inch so that vegetative debris can fall through rather than accumulate on the deck. Be sure to routinely clear debris from under the deck.
- If a deck is made of combustible decking materials, replace the board closest to the home with a noncombustible material.
- In new deck construction, consider using noncombustible or higher density decking products.
- Move combustible cushions from deck furniture to inside and relocate combustible furniture (especially those with woven components that can trap embers) away from the house.

Garages

Garages, whether attached to the home or detached as a separate building, can threaten homes if the garage ignites. Since it is normal to store combustible materials in a garage, steps should be taken to reduce the ignitability of the garage because embers can easily enter under or around poorly sealed garage doors.

HOW TO REDUCE THE VULNERABILITY OF GARAGES

- Whether a garage is detached or attached, include it in defensible space planning and maintenance, including the ember-resistant zone.
- Make sure the space between the garage door and framing is well sealed to minimize the entry of embers into the garage.
- Garage windows, vents and other construction components should be treated the same as they would be if part of the home.
- Add a battery back-up to the garage door motor so that the garage can easily be opened or closed if power is out.
- Close garage doors when wildfire is threatening.



← *Make sure garage doors are well sealed and closed before evacuating.*

A *Cover the stovepipe/ chimney with a metal screen (no smaller than ⅜-inch and no larger than ½-inch).*

B *Install metal flashing at the chimney-roof intersection.*

Chimneys

Chimneys and stovepipes can be a vulnerable part of the home if not installed correctly and properly cleaned and maintained annually. Vegetative debris can accumulate on the roof adjacent to the chimney chase. This is another roof-to-wall connection that can be vulnerable to ignition by embers.

HOW TO REDUCE THE VULNERABILITY OF CHIMNEYS

- Use of metal step flashing at roof-to-siding intersection (flashing extending up the wall) can reduce the vulnerability to embers.
- Cover chimney and stovepipe outlets with a noncombustible screen. Use metal screen material with openings no smaller than ⅜-inch and no larger than ½-inch to minimize embers leaving the chimney.
- Close the fireplace flue during fire season when the chimney is not in use.

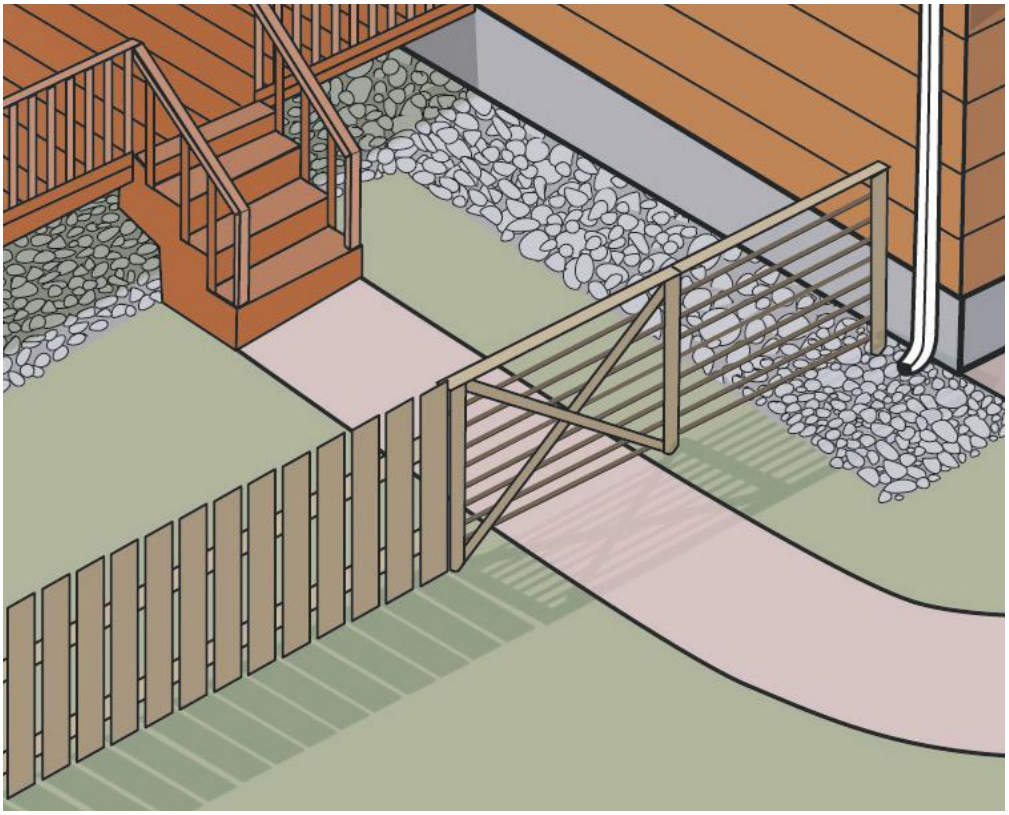
Fences

Combustible fencing can provide a direct path to a home if surrounding vegetation or embers ignite it. Best practice is to separate the fence from the house or upgrade the last 5-feet of the fence to a noncombustible material to reduce the chance of the fence from bringing fire to the home.

Privacy fences (planks all on one side of horizontal supports) are the most vulnerable to ignition because the horizontal to vertical intersection provides a ledge and backstop where embers can accumulate and ignite the fence. Good neighbor (planks alternating) and lattice are more porous, and therefore more difficult to ignite via ember exposure. Vinyl fences are not as vulnerable to embers, but can ignite through direct flame exposure if vegetative debris has accumulated at its base. As is the case with vinyl siding, vinyl fencing will be vulnerable to deformation from radiant heat exposure. All fences are more vulnerable when vegetative debris has accumulated at their base.

HOW TO REDUCE THE VULNERABILITY OF FENCES

- Replace the combustible portion of the fence near the home with a noncombustible section. The noncombustible section should be a minimum of 5-feet long.
- Remove vegetative debris that can accumulate at the base of the fence on a regular basis. Do not use fences as a trellis for plants because plants can create and trap ignitable vegetative debris.



← *Rather than replacing the entire fence, replace the 5-feet closest to the home with a noncombustible option.*

Glossary

BEVEL JOINT A type of lap joint, typically seen in horizontally applied siding. This lap joint, when used with a combustible siding product, is the most vulnerable to fire penetration.

CHIMNEY CHASE The area or structure around metal flue pipes. The chase is usually built with wood, metal or brick.

DORMER A part of a building that extends beyond the vertical plane of the roof. This extension also has a roof covering and typically incorporates a window on the exterior wall.

EMBER Also called firebrand. Burning (or glowing) particles of vegetation from tree branches, parts of shrubs or chaparral, or other combustible materials (e.g., construction materials) that ignite and burn during a wildfire and are carried in wind currents to locations beyond the wildfire front.

FIBER CEMENT A generic term for a siding product that is made using cement, wood fiber and other additives.

FINE-MESH SCREENING In the context of this document, ⅛-inch or finer screening that is used to cover vent openings and operable windows.

FOIL-FACE BITUMEN TAPE A flashing material whereby an aluminum foil material is part of a bitumen tape system.

GOOD-NEIGHBOR FENCE In the context of this document, this type of fence is one where the vertical planks alternate between the sides of the horizontal support members. A "good-neighbor" fence is usually compared to a "privacy" fence, where the vertical planks are all on the same side of the horizontal supports.

GYPSUM WALLBOARD A panelized product made from calcium sulfate dihydrate. These panels are commonly used for paneling on the interior of homes and buildings. A special type of gypsum wallboard can be used as a fire-resistant component in a one-hour wall assembly.

LADDER FUELS Low-lying branches and vegetation that can help carry flames from the surface into the canopy of trees or shrubs.

LAMINATED GLASS A type of safety glass that consists of two (or more) layers of annealed glass that are connected with adhesive interlayers.

LAP JOINT The type of overlap connection between boards or panels on the siding of a building.

METAL DRIP EDGE FLASHING Also called angle flashing, this material is typically used to protect the edge of the roof where the roof covering meets the exterior (vertical) framing.

MULTI-PANE WINDOW A term used to indicate multiple glass panes in a window. One pane of glass would be indicated by "single-pane."

ONE-HOUR WALL CONSTRUCTION An assembly that provides enhanced resistance to the penetration of fire.

OPEN-EAVE A type of construction whereby roof rafters are exposed in the area where they extend beyond the exterior walls of the building. In this type of construction, wood members, typical nominal 2-inch thick lumber, are used to fill the space between roof rafters.

PLASTIC-CLAD FIBERGLASS SCREENING Commonly used window screening material. Typical screen size is 1/16-inch mesh.

PRESSURE-IMPREGNATED FIRE-RETARDANT TREATED A process whereby a fire-retardant chemical is injected into the material (e.g., wood) under a pressurized process. This process results in a deeper penetration of the chemical into the wood.

ROOF COVERING The part of the roof assembly visible from outside the building. Common roof covering materials include asphalt composition shingles, tile and metal.

SHEATHING The first covering of boards or of waterproof material on the outside wall of the house.

SHIPLAP A type of lap joint used for horizontal and vertical siding. Along with tongue-and-groove pattern, this pattern is a better choice when considering improved resistance to fire penetration.

SOFFITED-EAVE A type of construction where the area of the roof rafters that extend beyond the exterior wall of a building are enclosed, typically by attaching a panelized product that connects the edge of the roof to the exterior wall.

STUCCO A siding material usually consisting of a mixture of sand, Portland cement, lime, water and other additives.

TEMPERED GLASS A heat-treated glass that enhances resistance to heat exposures three to four times over that of regular (annealed) glass.

UNDERLAYMENT A panel or sheet material in the roof assembly, underlying the roof covering, that improves the fire rating of the covering.

VENT COVER A solid material used to temporarily cover a vent opening to prevent the entry of embers.

Online Resources

The following websites have resources and information on home-hardening, defensible space, and other tips to prepare for wildfire.

Living With Fire Program - www. livingwithfire.com

University of California Agriculture and Natural Resources - www.ucanr.edu/sites/fire

Insurance Institute for Home and Business Safety–Wildfire - www.ibhs.org

CAL FIRE Ready for Wildfire - www.readyforwildfire.org

Sustainable Defensible Space - www.defensiblespace.org

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Partner Logos

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LIVING WITH FIRE TAHOE

Photo Courtesy of California Tahoe Conservancy / Nick Spannagel