

FIRE Safe
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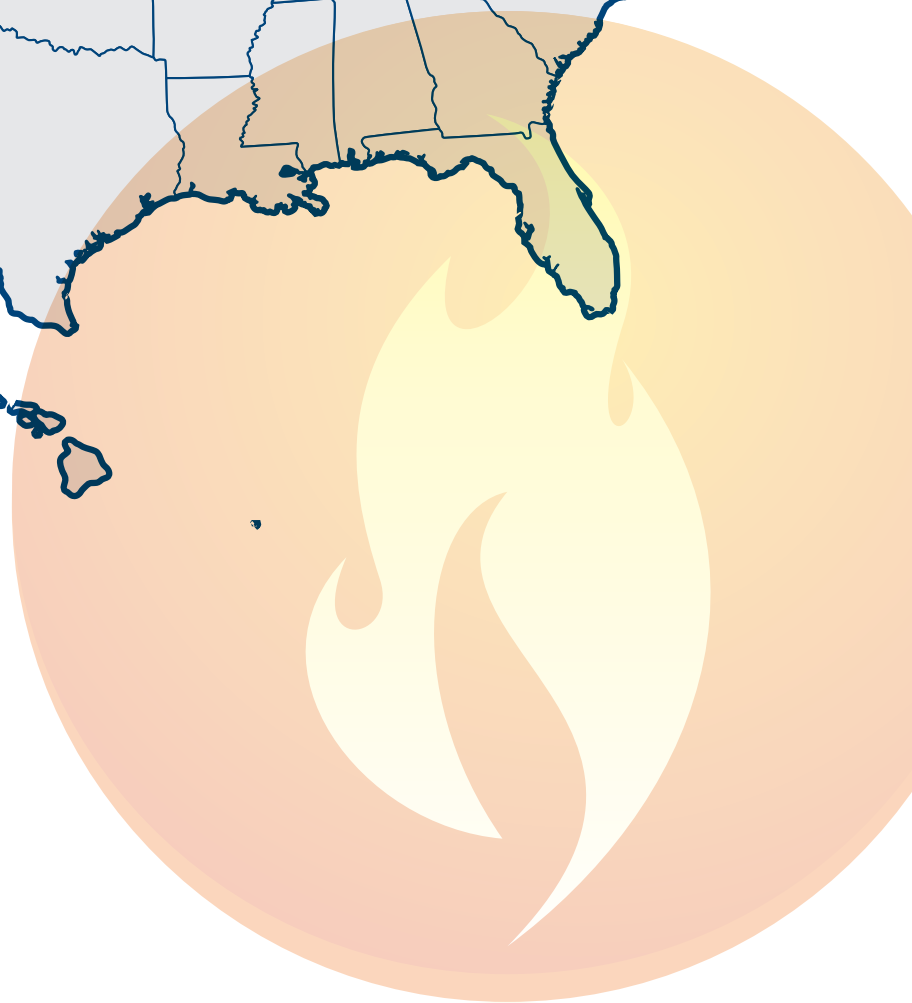
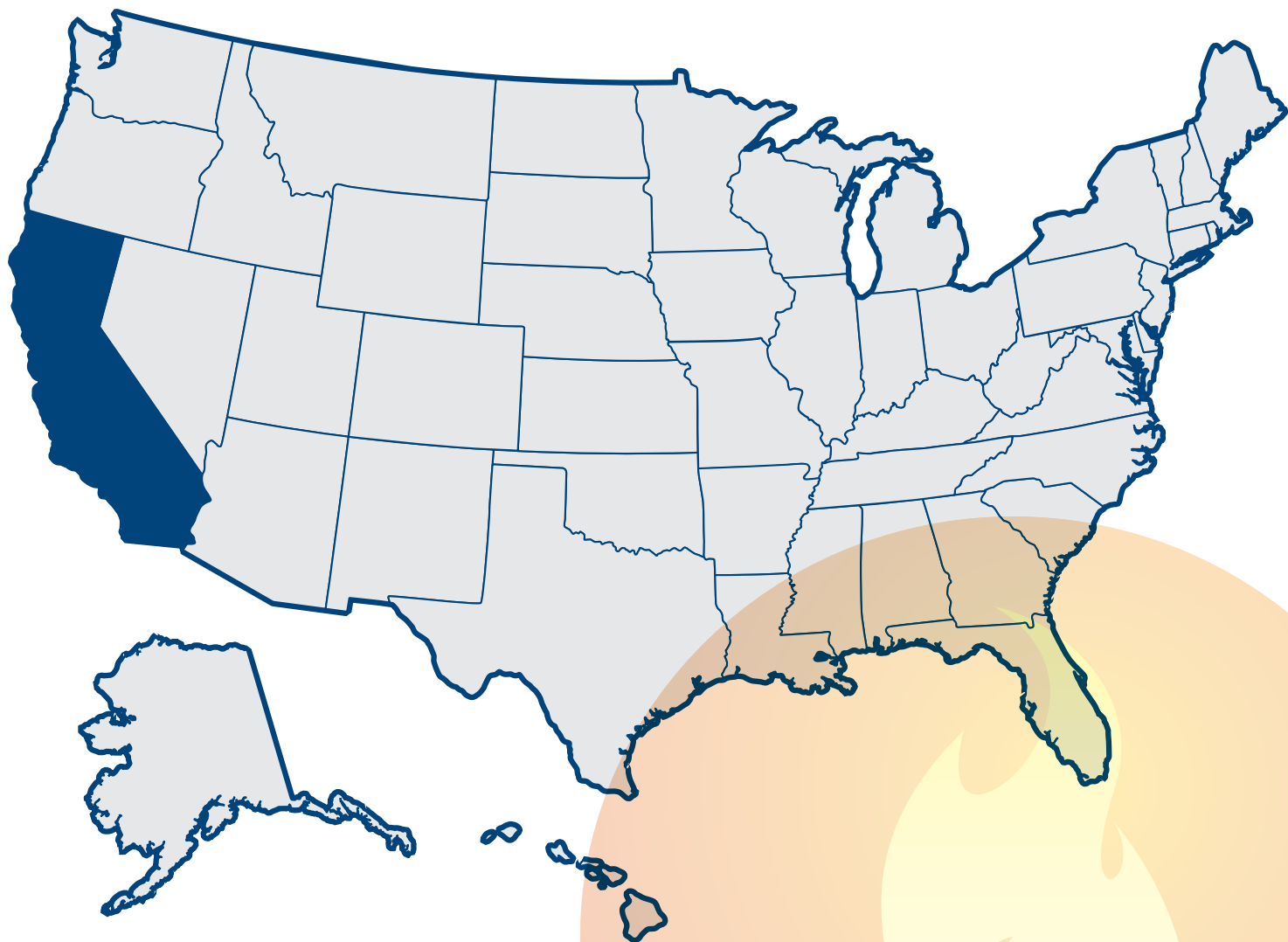


Protect Your Property from Wildfire



Table of Contents

4	You Can Make a Difference <ul style="list-style-type: none">• An Overview of this Guide: Reducing the Vulnerability of Your Home or Business• Managing Vegetation and Other Combustible Materials Around Your Home or Business<ul style="list-style-type: none">◦ Defensible Space• Understanding Terms: The Role of Building Codes and Test Standards for Materials<ul style="list-style-type: none">◦ California Building Code Chapter 7A Summary• Improving the Wildfire Resistance of Your Home or Business
9	Roof Covering <ul style="list-style-type: none">• Things to Keep in Mind When Choosing a Class A Roof Covering• Tile and Other Roof Coverings with Gaps at the Edges• Skylights
12	Gutters
13	Vents: Under-Eave, Attic and Crawl Space (Foundation)
15	Windows and Doors
18	Decks, Patios and Porches
21	Siding
23	Fences
24	Chimneys, Burn Barrels and Open Debris Burning
25	Vegetative Fuels Treatments Away from Buildings
25	Creating Defensible Space <ul style="list-style-type: none">• Identifying Fuels Management Zones• Defensible Space<ul style="list-style-type: none">◦ Zone 1: 0-5 Feet (Near-Home Noncombustible Zone)◦ Zone 2: 5-30 Feet (Lean, Clean and Green Zone)◦ Zone 3: 30-100 Feet
30	Firewood, Leftover Materials and Combustible Materials
30	Plants
31	Yard and Garden Structures
32	Outbuildings, Fuel Tanks and Combustibles
33	Importance of Topography
34	Importance of Environmental Condition
34	Defensive Actions <ul style="list-style-type: none">• If You are Trapped and Cannot Leave• External Water Spray System• Gel Coatings
37	Additional Resources for Vegetation/Plant Selections





YOU CAN MAKE A DIFFERENCE

Research and post-fire assessments have shown that property owners can protect their homes and businesses against wildfire by addressing three clear sources of vulnerability: materials and design features used in building the home or business, the landscaping vegetation located immediately adjacent to the home or business, and the general vegetation and other combustible materials and items on the property surrounding the home or business. Each of these sources can be dealt with through maintenance, appropriate choices in building materials, design improvements, and vegetation management.

Making your home or business and community better able to survive a wildfire is a process that will be well worth the effort. Some projects can be done in a weekend, although it is important to remember that routine maintenance must be part of any long-term plan to reduce the vulnerability of your home or business to wildfire.

This guide was created specifically for Californians and considers appropriate building styles and construction materials, common topographical features, and other factors. While reducing the vulnerability of your home or business to wildfire begins with you, a community-wide approach to fire protection will be the most effective, so please share this guide with friends and neighbors. This guide will provide information that will help your home or business and your community prepare for and survive a wildfire.

Reducing the Vulnerability of Your Home or Business: An Overview of this Guide

Wildfires can be difficult to control. What is controllable is how you prepare your home or business for wildfire before it threatens. Ultimately, the difference between survival and destruction are the steps you take to reduce the opportunity for the initial ignition of your home or business. There is an explicit link between the selected vegetation, its placement and management in the area surrounding a building, often referred to as “defensible space,” and construction materials and building design. Survivability of a building will depend on creating and maintaining an effective defensible space on the property and on careful selection of building materials and construction design features.

The ignition of a building during a wildfire can occur in one of three ways. These include exposure to wind-blown embers (also known as “firebrands”), direct contact by flames, or a radiant heat exposure (radiant heat is the heat felt standing near a burning object, such as a campfire; but during a wildfire, the heat source could include burning items such as a woodpile, tool shed and/or a large shrub). Of these, exposure to wind-blown embers is considered the most important. Wind-blown embers generated by the burning wildland vegetation, or other burning buildings or structures, can land on or near your home or business and ignite it either directly or indirectly. Examples of a direct ember ignition include ember entry through a vent or open window with subsequent ignition of combustible materials or furnishings inside the building. Direct ignition by embers also can occur through sufficient ember accumulation on combustible materials such as a wood shake roof, on combustible decking, or immediately adjacent to combustible materials such as siding. Examples of an indirect exposure include ember accumulation and ignition of vegetation or other combustible materials (e.g., a woodpile or shed) located near your home or business, with subsequent ignition of a building component by a radiant and/





or direct flame contact exposure. With inadequate defensible space, the wildfire could burn directly to your home or business and ignite an exterior component, or break the glass in a window and ultimately burn into the interior of the building. Developing and maintaining an effective defensible space will minimize the chance of this happening.

Once homes and other structures ignite and burn, they will become a source of embers and threaten other homes and buildings. Depending on building-to-building spacing and topographical features, one wildland fire-to-building ignition can result in additional ignitions by building-to-building fire spread. Building-to-building ignitions can result from embers, direct flame contact and/or radiant heat exposures. The potential damage from radiant heat will depend on the level and duration of the exposure. The radiant heat exposure from a burning building will be longer than that from a burning shrub.

This guide provides information for reducing the vulnerability of your home or business to wildfire. Vulnerable parts of a building include the roof, the area immediately adjacent to the building and under any attached deck, vents and other openings on the exterior walls, gutters, decks and siding. Specific details on reducing the vulnerability of your home or business will be provided in the “Improving the Wildfire Resistance of Buildings” section of this guide.

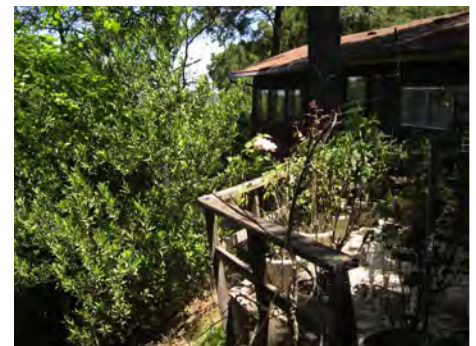
MANAGING VEGETATION AND OTHER COMBUSTIBLE MATERIALS AROUND YOUR HOME OR BUSINESS

Defensible Space

For the purpose of this document, defensible space is the area between your home or business and an oncoming wildfire where the vegetation has been managed, by pruning, thinning, removal, or replacement, to reduce the severity of the wildfire and improve the likelihood of a home or business surviving without assistance from firefighters (Living with Fire Program, University of Nevada Cooperative Extension, 2012). These actions reduce the chance that flames will touch any part of a building and that the associated radiant heat will be able to break window glass, ignite combustible siding, or ignite combustible items stored close to the building. Regardless of the size of the property surrounding the building, the goal is the same: to reduce and manage the amount and location of combustible vegetation and other combustible materials that would allow the wildfire to get close enough to the building to result in ignition.

Since 2005, Californians in designated wildfire-prone areas have been required by law to create 100 feet of defensible space around their home. Initially this requirement applied to those living in more rural areas (i.e., those living in State Responsibility Areas [lands where the State has the financial responsibility for prevention and suppression of wildfires]), but today it also applies to those living in urban and suburban areas in certain wildfire-prone areas determined to be “very high” hazard. Areas where native vegetation abuts a community is often referred to as the wildland urban interface, or WUI.

Similar to defensible space around a building, a fuel break can be created and maintained around a community. The goals of a community-wide fuel break or parcel-level defensible space are the same: to reduce the intensity of the fire, to drop any fire burning in the upper part of trees (the “crown”) or shrubs to the ground and keep it from climbing back into the crown, and to minimize the chance of the fire burning to the home or business. If these community-wide



The defensible space on this property could be improved by removing vegetation to minimize the opportunity for fire to burn directly to the home. Source: Stephen L. Quarles



goals are achieved, the home or business would still need to be protected from burning wind-blown embers that can be transported over any property-level defensible space.

Learn more in the “Creating Defensible Space” section of this guide.

UNDERSTANDING TERMS: THE ROLE OF BUILDING CODES AND TEST STANDARDS FOR MATERIALS

When improving the ability of a home or business to survive a wildfire, it is important to understand a few key terms. These include “noncombustible,” “ignition-resistant,” and “combustible.” The term “flammable” usually applies to fluids and so will not be generally used in this document. Based on commonly used terminology, an ignition-resistant material is still a combustible material. The following paragraphs provide more detailed descriptions.

A combustible material has been defined in an American Society for Testing and Materials standard (ASTM E176 - Standard Terminology of Fire Standards) as one that is capable of undergoing combustion under specified conditions. Whether or not a material can be considered noncombustible can also be determined using a standard test method (ASTM E136 - Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C). Examples of noncombustible materials include traditional three-coat stucco, metal (with the exception of aluminum) and some fiber-cement construction products (e.g., fiber-cement siding and soffit materials).

Chapter 7A (Materials and Construction Methods for Exterior Wildfire Exposure) of the California Building Code, the International Code Council’s International Wildland-Urban Interface Code (IWUIC) and the National Fire Protection Association (NFPA) Standard 1144 (Standard for Reducing Structure Ignition Hazards from Wildland Fire) have defined an ignition-resistant material (IRM) as one meeting a minimum flame spread index. An example of an ignition-resistant material is lumber that has been pressure impregnated with a fire-retardant chemical and rated for use in an outdoor environment. Suitability for use in an exterior environment is determined by successfully passing the standard fire test after being subjected to an accelerated weathering procedure that consists of a number of wetting and drying cycles and exposure to ultraviolet light. The weathering cycle is used to remove fire-retardant chemicals that might be easily removed from the material while in service.

Many products commonly used on the outside of homes or businesses are combustible. These include solid wood and wood-based composite materials (e.g., T1-11 plywood siding and solid wood decking) and plastic and wood-plastic composite materials (e.g., decking, trim and vinyl siding). The relative performance of combustible materials can be evaluated by comparing the amount of heat that is generated when it burns (referred to as the “Heat Release Rate”); the ability of a construction assembly, such as an exterior wall, to resist fire from moving from one side of the assembly to the other (generally referred to as “fire resistance”); the time it takes a material to ignite; and other factors that can be quantified.

These terms are used to describe and compare the fire performance of construction materials. Having a basic understanding of them can help you select products for your home or business. Chapter 7A in the California Building Code uses these terms to describe the requirements of materials that can be used in new construction. Some jurisdictions, during their code



Test to determine the fire rating for a roof covering. A Class A burning brand is on this roof covering. Photo taken during experiments conducted at the University of California Fire Research Laboratory. Source: Stephen L. Quarles



adoption process, incorporated a “significant remodel” provision that requires compliance with Chapter 7A if the remodel exceeds a specified square footage or dollar value. By understanding the differences in these terms—all of which relate to the relative combustibility of a material, product or construction feature—you will be better equipped to make choices when working with a contractor on a home or building improvement project by yourself.

California has been a leader in the field of wildfire building code development. As indicated, Chapter 7A of the California Building Code applies to new construction in designated wildfire-prone areas. In addition to noncombustible and ignition-resistant materials, this chapter uses State Fire Marshal–approved standard test methods that provide a way to evaluate and compare the performance of exterior-use construction materials, most of which fall into the combustible category. For more information about Chapter 7A, visit the following link or talk with your local building or fire official:

osfm.fire.ca.gov/code/development/wildfireprotectionbuildingconstruction.php

Many construction materials that have complied with the performance options of Chapter 7A are included in the Building Materials Listing Program, a program managed by the California Office of the State Fire Marshal. Product information can be found at:

osfm.fire.ca.gov/licensing/listings/license_listing_bml_searchcotest.php

As of January 1, 2011, residential fire sprinklers are required in all new one- and two-family dwellings and townhouse construction.



Conducting an underdeck flame impingement test to evaluate the performance of decking. This test method used a gas burner to simulate an exposure from burning combustible materials stored under a deck. The procedure later became the California State Fire Marshal test procedure for evaluating the performance of decking materials. Photo taken during experiments conducted at the University of California Fire Research Laboratory. Source: Stephen L. Quarles



CALIFORNIA BUILDING CODE: CHAPTER 7A SUMMARY

VEGETATION MANAGEMENT	BUILDING COMPONENTS
<ul style="list-style-type: none"> Follows Public Resources Code (PRC) 4291 <ul style="list-style-type: none"> Two zones: <ul style="list-style-type: none"> The Lean, Clean and Green Zone that includes the 30 feet immediately surrounding the home or building. The Reduced Fuel Zone that includes the zone from 30 to 100 feet (or to the property line). <p>The provisions of Chapter 7A apply to new construction (residential and commercial) and to remodels that occur on buildings constructed after 2008, when Chapter 7A was implemented. Check with your local building code official for any local modifications to the state building code.</p> <p>Some jurisdictions, during their code adoption process, incorporated a “significant remodel” provision that requires compliance with Chapter 7A if the remodel exceeds a specified square footage or dollar value.</p>	<ul style="list-style-type: none"> Roof: Class A, B, or C, depending on Fire Hazard Severity Zone. Gutters: Resist accumulation of debris, usually through use of cover devices. Vinyl and metal gutters are both okay. Vents: Corrosion-resistant metal mesh, not less than 1/16 inch. Under-eave vents not allowed unless accepted by the Office of the State Fire Marshal as resisting the entry of embers and flame. Siding: Noncombustible and ignition-resistant materials okay. Combustible siding products must pass a fire-resistance test. Windows: Dual-pane with at least one pane tempered glass. Any frame material is okay. Decking: Noncombustible okay. Combustible products must pass a test that evaluates heat release rate. Restrictions on siding products will apply if the decking product has a Class C flame spread index.

IMPROVING THE WILDFIRE RESISTANCE OF YOUR HOME OR BUSINESS

You may already have a list of projects to improve your home or business. Maybe you need a new roof, want to replace old windows to improve energy efficiency, or need to rebuild a deck. Review your list to see if it includes projects in any of the following sections. If so, by modifying your plans, you may be able to reduce the vulnerability of your home or business to wildfire.

ROOF COVERING

WHAT YOU SHOULD KNOW

Replacing a roof is a major project, but it can yield major benefits. Evaluating the vulnerability of the roof should be a top priority when considering a new home or business, or remodeling an existing property. An untreated wood shake or shingle roof covering is arguably the greatest threat to a building. The fire rating for a roof covering is either Class A, B, or C, with Class A providing the best performance. A non-fire-retardant-treated wood shake or shingle roof is unrated (i.e., it has less than a Class C fire rating).

Roof shape also affects the potential vulnerability of a roof. Roof designs that result in roof-to-vertical-wall intersections (e.g., at a dormer or a chimney chase), are often referred to as having a complex roof shape. If the vertical wall uses a combustible siding product, this detail can make your home more vulnerable to wildfire, even if you have a Class A roof covering, because vegetative debris can accumulate at these intersections. During a wildfire, so can wind-blown embers. If the roof is adjacent to a vertical wall with combustible siding, the ember-ignited vegetative debris could burn into the stud cavity and spread into the occupied portion of your home or business. Make sure that your roof covering doesn't "fail" because of the ignition of materials next to the covering, thereby bypassing the protection provided by a fire-rated roof covering or assembly.

WHAT YOU SHOULD DO

Regularly inspect the areas around your home or business, paying close attention to debris accumulation on the roof and in gutters. Remove accumulated debris.

It can be difficult to tell whether you have a Class A fire-rated roof. The most common example of a Class A covering is asphalt composition shingles. If you are not sure about the fire rating of your roof covering, schedule an inspection by a professional roofer to find out. If you replace your roof, choose one that has a Class A fire rating.

Regardless of the specific Class A roofing material you choose, inspect it regularly, maintain it when necessary, and replace it when needed.

Consider replacing combustible siding located on dormer or other vertical roof-to-wall locations with a noncombustible product. If you maintain an effective defensible space, including a near-home noncombustible zone, replacing combustible siding at all locations isn't as important. Replacing siding locally at these locations will be more affordable than global replacement on your home.

THINGS TO KEEP IN MIND WHEN CHOOSING A CLASS A ROOF COVERING

Many roof coverings have a Class A fire rating that is only based on the top/external covering (i.e., the part of the roof that you can see) and the balance of a normal roof assembly that consists of the sheathing and roofing felt or other underlayment material. Some common examples include asphalt fiberglass composition ("asphalt comp") shingles and clay or concrete tiles. These materials provide a "stand-alone" fire rating.



Wind-blown embers ignited debris on a roof next to dormer.



Other roof coverings obtain their Class A fire rating by adding materials that enhance the fire resistance of the roof assembly. The assembly is composed of the roof covering that you see, and the additional underlying material(s) that you can't see. The fire rating of these coverings will be referred to as Class A "by assembly." Examples include aluminum and some of the newer composite roof coverings made from recycled plastic and rubber materials. These products require an additional layer of a fire-resistant material to achieve a Class A fire rating. Wood shakes are available with pressure-impregnated, exterior-rated fire-retardant chemicals that provide a "stand-alone" Class B fire rating, and a Class A rating "by assembly." The recycled plastic and rubber roofing products typically have a Class C "stand-alone" fire rating.

The fire rating for most, but not all, roof coverings and assemblies are evaluated using new materials. An exception is fire-retardant-treated wood shakes and shingles, which (in California) must undergo a prescribed natural weathering exposure and then pass the required fire tests before being accepted for use. Weathering is a factor that is often overlooked when using roofing products. Over time, as the product weathers, some roof coverings may become more vulnerable to fire due to wear, repeated exposure to the elements and other types of damage. Some jurisdictions in California do not allow the use of fire-retardant-treated wood shakes or shingles as a roof covering. For more information about exterior pressure-impregnated fire-retardant-treated materials, see the "Building Materials & Home Design" section at www.extension.org/surviving_wildfire.

TILE AND OTHER ROOF COVERINGS WITH GAPS AT THE EDGES

WHAT YOU SHOULD KNOW

Some roofing materials have a gap between the roof covering and the roof sheathing. These gaps typically occur at the ridge and edge of the roof. The most common example of a covering material where this would occur is a clay barrel tile roof, but it also occurs in some metal roofs (mainly with a standing-seam style) and other cement roof coverings. Even with flat profiles, gaps occur at the ridge and hip of the roof. The larger gaps can allow birds and rodents to get into the opening and build nests between the roof covering and the roof deck. The small pieces of vegetation used as nesting material can be easily ignited by wind-blown embers. Over time, wind-blown debris will also enter through these gaps and accumulate on top of the roof deck (and below the roof covering), adding to the amount of combustible debris. Flames from the ember-ignited debris can then spread to the structural members that support the roof, bypassing the protection offered by the Class A (or other) fire-rated roof covering.



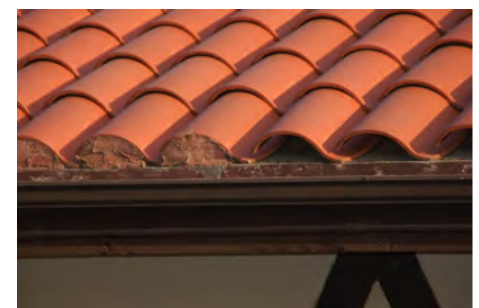
Commercially available bird-stop material. Note missing stop (a maintenance item) and gaps between bird-stop and roof covering. Ember entry still possible—size and number could be restricted, as would be birds and rodents. Source: firecenter.berkeley.edu/bwmg/roof-1.html



Detailing for a "by assembly" fire rating that includes a fiberglass gypsum product. Photo taken during experiments conducted at the University of California Fire Research Laboratory. Source: Stephen L. Quarles



Wear on an asphalt composition roof. Because the surface granules are missing, it is possible that the fire rating has been compromised, particularly at this location.



Use of mortar mix as a bird-stop material. Source: firecenter.berkeley.edu/bwmg/roof-1.html



WHAT YOU SHOULD DO

Use a form of protection called a “bird stop” to cover the open edge gaps between the roof covering and roof sheathing. Bird stops can either be a manufactured product purchased from a roofing supply store or provided by the manufacturer at the time of installation, or a mortar mix that is installed as a do-it-yourself project. The bird stop is inserted into the opening at the eave edge of the roof. Don’t forget to inspect the ridge and hips of your roof. A flat tile roof may or may not have a gap at the roof edge, but it will likely have openings at the ridge and hip. These openings also need to be closed. A mortar mix would be the best option to plug openings at the ridge and hips of the roof. The goal is to keep fuel sources, such as nesting materials and wind-blown debris, from getting under the fire-rated roof covering.

Some commercially available bird stops will still have small gaps between the edge of the bird stop and the roof covering, stopping birds from nesting but not embers from entering. A mortar product can completely fill the gaps. Bird-stopped areas must also be maintained, and repaired when necessary.

SKYLIGHTS

WHAT YOU SHOULD KNOW

Skylights can be vulnerable during a wildfire in two ways. First, the intersection between the skylight and the roof can collect combustible wind-blown litter (e.g., leaves, twigs and pine needles) and embers. Debris can accumulate on top of the skylight, particularly those with a flat (glass) surface when installed on a flat or low-slope roof. Second, depending upon its material, the lens can be damaged or melted by radiant heat or direct flame contact. The potential for damage from a radiant heat exposure would be more likely when the skylight is installed on a steeper sloped roof, particularly if there is vegetation or a building in a direct line of site with the skylight.

WHAT YOU SHOULD DO

Regularly inspect your roof for debris accumulation on and around skylights. Remove accumulated debris. Debris can accumulate on a roof with any slope, but it is more likely to accumulate on top of a skylight installed on a flat roof. Flat surface skylights (glass types) are more susceptible to accumulating debris than domed (plastic) types.



Skylight on a steep-slope roof. Radiant heat exposure from burning vegetation or building would be more of a problem with steeper sloped roofs.



The tiles on this roof are damaged and should be replaced.



Flat (top photo) and domed (bottom photo) skylights. Note propensity for debris to accumulate on top of flat versus domed skylights.



GUTTERS

WHAT YOU SHOULD KNOW

Wind-blown vegetative debris and debris from overhanging trees will result in the accumulation of leaves and needles on your roof and in your gutters. If dry, this debris can be readily ignited by wind-blown embers. Even if you have a Class A fire-rated roof covering, such as tile, concrete, metal or asphalt composition shingles, the edge of the roof will be exposed to flames from the ignited debris.

Many checklists suggest replacing vinyl gutters with metal gutters. Debris in any gutter will be readily ignited by embers. Once debris in a vinyl gutter has ignited, the gutter will ultimately detach at the roof edge and fall to the ground. The debris and gutter will burn on the ground, potentially igniting surrounding vegetation and combustible mulch, and adjacent combustible siding or other components in the wall assembly. A metal gutter will remain attached to the edge of the roof and the ignited debris will continue to burn there, exposing the edge of the roof, including sheathing and fascia, to flames. The best solution is to minimize the accumulation of debris in the gutter.

When dry, decayed wood and other wood-based materials that are commonly used in the under-eave and soffit can be more easily ignited.

WHAT YOU SHOULD DO

Remove tree branches that overhang your roof and remove any dead vegetation, including branches, within your defensible space. This should be part of a routine maintenance plan around your home or business. Do this at least annually at a time best suited for the health of the tree or plant.

Clean gutters and roof areas where debris collects. Inspect and remove accumulated debris in these areas at least twice a year, or more if necessary. Remove accumulated leaves, pine needles and any other combustible debris.

Inspect the roof edge to determine if a metal drip edge is installed, or included as part of your gutter. Some metal gutters have an integral flashing piece that serves the function of a stand-alone drip edge. If a drip edge is not present, install one. The drip edge will serve two purposes: (1) it will help protect the roof edge (sheathing and fascia) from a flaming exposure that could occur if debris is ignited by wind-blown embers, and (2) it will minimize the entry of embers into a soffit-eave construction by blocking the small gap that can exist between the edge of the roof sheathing and the top of the fascia.

Inspect exposed portion of the under-eave or soffit periodically to make sure construction material is in good condition.



Wind-blown embers ignited debris in a gutter. Photo shows detaching vinyl gutter (left side) and attached metal gutter (right side).



Gutter with integrated drip edge.
Source: firecenter.berkeley.edu/bwmg/gutters.html



Decayed wood at the roof edge—more readily ignited from any flaming exposure resulting from burning debris in the gutter. Source: Stephen L. Quarles



Covering your gutters with screens or other devices can minimize the buildup of debris in the gutter. Regularly inspect gutters with cover devices to make sure they are still in place and performing properly. If you choose to use one of these devices, select one that is made of a noncombustible material. Also be aware that some screens and cover devices will allow debris to accumulate on the roof behind the device. If ignited, this flaming debris can increase your vulnerability if you don't have a Class A fire-rated roof covering. Even if you have a Class A roof cover, debris should still be removed on a regular basis to reduce ember generation and exposure to other parts of your home or business.

VENTS: UNDER-EAVE, ATTIC AND CRAWL SPACE (FOUNDATION)

WHAT YOU SHOULD KNOW

Attic, roof and foundation vents can be entry points for embers and flames. Embers that enter the attic or crawl space can ignite combustible debris that can accumulate in these spaces and also combustible materials stored in these spaces. Testing by IBHS and the National Institute of Standards and Technology (NIST) has demonstrated the vulnerability of vents mounted on vertical walls and surfaces to the entry of embers. These vents included gable end and foundation vents, and vents in the blocking in open-eave construction. Open-eave construction is one where you can see the rafter tails of your roof framing on the exterior underside of your roof. Vents in a soffited (boxed-in) eave were not as vulnerable to ember entry. Based on research conducted at the University of California and IBHS, there is increasing evidence that soffited eaves are less vulnerable to both ember and direct flame contact exposures.

Open-eave construction can be vulnerable even if vents are absent. If the blocking is improperly installed or if it has warped over time, gaps can develop where the blocking and rafter tails intersect. As a result, wind-blown embers could become lodged there and ignite debris and potentially the structural support wood members in these areas.

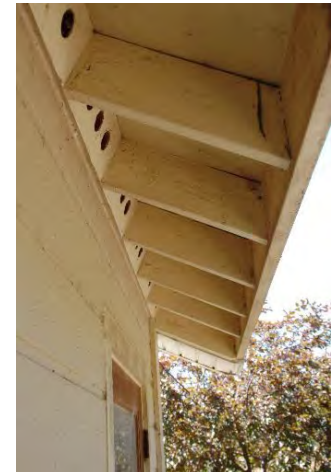
Based on testing conducted at the IBHS Research Center, dormer-type through-roof vents are vulnerable to ember entry. Ridge vents rated to resist the entry of wind-driven rain will also resist the entry of embers.

WHAT YOU SHOULD DO

If you have vented openings to your attic or crawl space, make sure screening is present. At a minimum, these vents should be covered with $\frac{1}{8}$ -inch corrosion-resistant metal mesh screen. Chapter 7A of the California Building Code will allow $\frac{1}{16}$ -inch screening. Laboratory research has shown that embers large enough to pass through $\frac{1}{4}$ -inch and even $\frac{1}{8}$ -inch screens are large enough to ignite fine fuels, so while screening will help, it won't be the perfect answer. While a finer mesh screen will offer better protection against the entry of embers, it will also require more maintenance to keep it free of debris. It is important to allow air to flow freely to help manage the moisture in your attic and crawl space (i.e., keep the moisture content low enough to minimize the chance of developing water-related damage to susceptible building materials).



Debris accumulation on roof covering behind gutter cover device. Source: firecenter.berkeley.edu/bwmg/gutters.html



Open eave (top photo) and soffited eave (bottom photo) construction. Source: firecenter.berkeley.edu/bwmg/soffit-eave-1.html



Note that flames can pass through $\frac{1}{4}$ - and $\frac{1}{8}$ -inch mesh screening, reinforcing the importance of actions that minimize the opportunity for flames to impinge on attic and crawl space vents, and other screened openings on the exterior wall.

Avoid the use of gable end vents—they have been shown to be vulnerable to ember entry. Consider instead a ridge vent that has an external baffle. These are effective in resisting the entry of embers. In order to be used in construction where Chapter 7A applies, a plastic ridge vent must be covered with a noncombustible wire mesh.



Ridge vents are typically plastic and therefore combustible. Removal of debris from the inlet to any ridge vent is critical since this debris could be ignited by wind-blown embers.

New vents have been designed as a result of the regulations in Chapter 7A of the California Building Code. These vents are intended to offer enhanced protection by reducing the number of embers (and the potential for flames) entering the space behind the vent. These vents typically incorporate certain design features to enhance performance over that of metal screening. They must also demonstrate enhanced ability to resist a flame contact exposure. Find a list of accepted vents at:

osfm.fire.ca.gov/licensinglistings/licenselistings_bml_searchcotest

Select “8165—Vents for Wildland Urban Interface (W.U.I.)” from the “Category” drop-down menu and then click the “Search” button.

Depending on the ease of accessing your vents, you could prepare vent covers (i.e., using $\frac{3}{8}$ - to $\frac{1}{2}$ -inch plywood and a thin metal plate) and include their installation as part of your wildfire pre-evacuation preparedness plan. Use of duct or metal tape could also be used as a last-minute effort. As indicated, these would be particularly useful for vents on vertical surfaces (gable end, foundation, and blocking in open-eave construction) since these types of vents and vent locations have shown to be vulnerable to embers. The covering should be removed after the wildfire threat has passed.

Closure devices for gable end and open-eave vents are also commercially available. These devices are manually activated (i.e., closed) by turning or pulling a wall- or ceiling-mounted handle. Currently, these closure devices would have to be manually reopened after the wildfire threat has passed.



This finer mesh screen was painted over when this building was repainted, minimizing airflow through the vent. The vent is damaged, allowing air and wind-blown embers to more easily pass through. Source: firecenter.berkeley.edu/bwmg/vents-1.html



A ridge vent that has an external baffle has been shown to resist the entry of wind-blown embers.



If you have open eaves (i.e., you can see the exposed rafters in the eave), you can use a sealant (such as caulking) to plug any gaps that you observe, or enclose the underside of the roof eave/overhang. Given the benefit from both an ember entry and flame contact exposure, enclosing the eave is highly recommended. To do this, use sheathing made from a noncombustible or ignition-resistant material. This enclosure can be horizontal or follow the slope of the roof and is sometimes referred to as boxing-in the eave. Enclosure would preferably be accomplished by extending the soffit material from the roof edge horizontally back to the exterior wall, thereby creating a soffit eave. The horizontal soffit member is attached to a ledger board that is itself attached to the exterior wall. If open-eave blocking includes vents, remember to add an adequate amount of soffit vents as part of your project. Make sure your vent-area ratio (vent into the enclosed soffit and enclosed soffit into the attic) follows the requirements of your local building code.

WINDOWS AND DOORS

WHAT YOU SHOULD KNOW

Windows are vulnerable to radiant heat exposures from nearby burning objects (e.g., vegetation, gazebos, decks, and other structures) and direct flame contact exposures from burning vegetation or other combustible materials stored under or near the window. Window failure can occur if the glass in the window breaks, allowing embers and flames to enter the building, or the combustible frame ignites and the fire is able to move into the occupied space. Common framing material includes wood, vinyl-clad wood, metal-clad wood (aluminum is the most common metal used in this application), metal (again, aluminum is the most common material), and vinyl. Fiberglass and wood-plastic composite materials are also used as framing materials by some manufacturers.

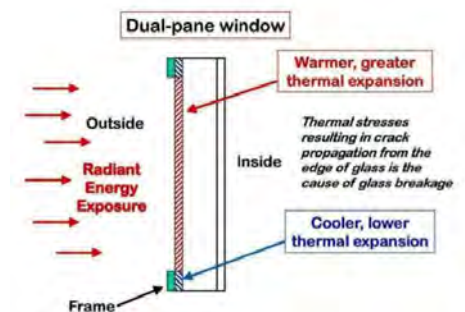
Studies have shown that the glass is the most vulnerable part of the window (i.e., the glass is more vulnerable than the frame). Glass breaks because of temperature differences that develop between the exposed glass and the glass protected by the window framing material. These temperature differences can occur when the window is subjected to the heat from a wildfire, including radiant heat from your neighbor's property. When this happens, cracks develop at the edge of the glass and propagate inward. This makes larger windows more vulnerable to breaking because they have a larger perimeter than smaller windows. Depending on the type of glass and level of exposure, failure (breakage) can occur after 1–3 minutes of exposure to direct flames or radiant heat.

Typical types of glass used in residential construction are either “annealed” or “tempered.” Annealed glass is more common. Because of life-safety issues, tempered glass is commonly found in doors and in windows that are located close to the floor. Tempered glass resists breakage from both mechanical and thermal stresses much better than annealed glass and is therefore a good choice for use in wildfire-prone areas. In addition, when it breaks, small chunks rather than sharp shards are created.

Laminated glass, which consists of a layer of a thin plastic membrane sandwiched between two layers of glass, is also available. Based on research conducted in Australia, the resistance to heat exposure for laminated glass is similar to that of annealed glass. Although not extensively studied, the same Australian study showed that application of a metallic film to an exposed glass



Gaps between the blocking and framing in the unvented truss bays would allow ember entry into the attic space. A sealant could be used to close gap. Source: Stephen L. Quarles



Glass breakage occurs as a result of temperature differences between the exposed glass and that protected by the frame material.



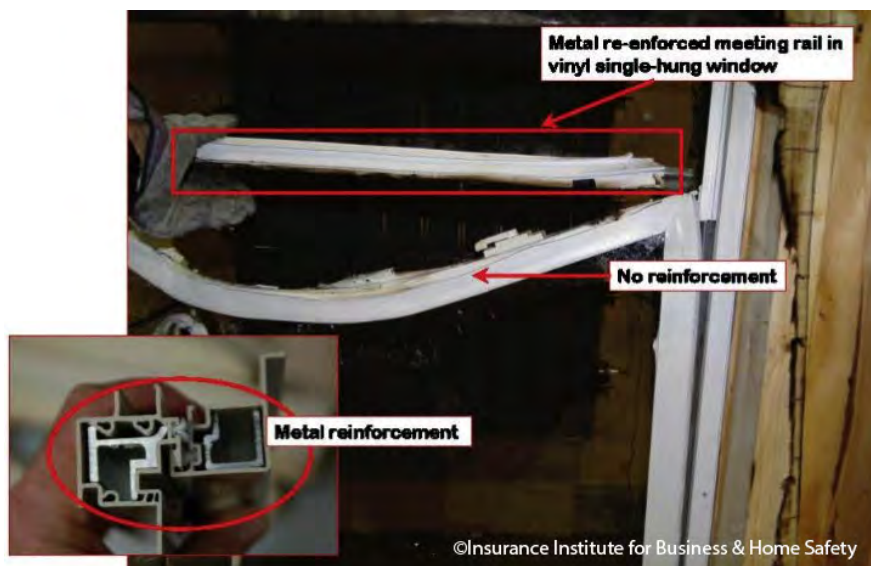
surface can improve resistance to heat exposure. It was reported that correct application of the film, according to the manufacturer's specifications, is important.¹

Older windows may consist of a single pane of glass. Newer windows are "dual-pane" or "multi-pane." In general, dual- or multi-pane windows are better choices from both a wildfire resistance and energy efficiency perspective.

Chapter 7A of the California Building Code, the chapter that applies to new construction in wildfire-prone areas, acknowledges the importance of tempered glass and the research results regarding the relative performance of framing material in that, at a minimum, at least one pane of a dual-pane window is now required to be tempered. This requirement does not override other sections of the code that require two tempered panes in a dual-pane unit. Note that even dual-pane, tempered glass windows will not protect your home or business if left open; therefore, close all windows before leaving home when a wildfire is threatening.

If you have a wide sill area at the bottom of the outside part of the window, regularly remove accumulated debris. In order to limit the chance of a flame contact exposure to the window, combustible mulch and woody vegetation should be avoided in areas immediately under it.

If you have a wood window, inspect it to make sure it is in good condition. Replace or repair it if the members become decayed—decayed wood is more easily ignited. Vinyl windows may deform if exposed to radiant heat. The horizontal member in a single- or double-hung window, and the vertical member in a horizontal slider window, can be particularly vulnerable to radiant heat. Vinyl windows with metal reinforcement in these members have been shown to mitigate this vulnerability. Windows certified by the American Architectural Manufacturers Association (AAMA) will have this metal reinforcement.



The framing member in the middle of a single- or double-hung vinyl window should include a metal reinforcement member.



Windows that comply with Chapter 7A provisions will have a label similar to that shown here.



Decay in the sash of a wood window. Source: Stephen L. Quarles

¹ (P.A. Bowditch, A.J. Sargeant, J.E. Leonard and L. Macindoe, 2006. Window and Glazing Exposure to Laboratory-Simulated Bushfire. Bushfire CRC, Confidential CMIT Doc. 2006-205. pp. 61)



As previously stated, the most vulnerable window during a wildfire is one that is left open. If a window is inadvertently left open, screens will help protect against ember entry. Screens will also protect the glass against radiant exposures that may otherwise cause the glass to break. Screens will not protect the window from a direct flame contact exposure (e.g., flames from vegetation or combustible siding located under or adjacent to the window that has ignited). Plastic-clad fiberglass screens will quickly fail as a result of a direct flame contact exposure.

Testing at the IBHS Research Center has demonstrated that window curtains ignite after the annealed or tempered window glass breaks and falls out, as a result of extended exposure to radiant heat and/or flames. While in place, the glass (and any screening) will effectively keep out enough radiant heat to avoid ignition of interior items. Depending on the extent and duration of the radiant exposure, vinyl blinds may deform.

WHAT YOU SHOULD DO

Determine what kind of windows are in your home or business. Single-pane windows are more common in older buildings. Dual-pane (or multi-pane) windows have two (or more) pieces of glass that are separated by airspace(s). The most important element is the use of tempered glass. To find out if your windows contain tempered glass, look for an etching (called a “bug”) in the corner.

When you replace your windows, choose new ones with tempered glass. Considering that current energy code requirements usually call for dual-pane windows, upgrading from a single-pane to a dual-pane window will improve both fire resistance and energy efficiency.

If you cannot afford to replace your windows, it is even more important to carefully manage and maintain the fuels closest to your home or business. This includes both vegetation and combustible materials such as firewood and lumber. Avoid storing combustible materials near your home or business. A noncombustible rock-type mulch should be used in the area immediately adjacent to your home or business.

If windows are accessible, you could consider preparing covers that would be installed as part of your evacuation activities. Shutters can be made from ¼- or ½-inch plywood, and should be cut to size and labeled (for each window) in advance to allow for easier and quicker installation when a wildfire threatens. Take the time to pre-install the anchorage system. Use of shutters can be more important if a neighbor’s home, or other non-movable structure, is nearby. The ¼- to ½-inch plywood will provide an extra measure of protection from radiant heat. Buildings that are used seasonally may already have shutters that are closed during the off-season to provide protection against intruders. These shutters will also protect windows and buildings during wildfires.



This cotton curtain ignited after both panes of a dual-pane window broke and fell out.



Etched “bug” in the corner of a window indicates that the window glass is tempered. Source: Stephen L. Quarles



DECKS, PATIOS AND PORCHES

WHAT YOU SHOULD KNOW

There are two general kinds of walking surfaces on decks and porches. One is made using spaced deck boards (e.g., wood, plastic or wood-plastic composite products), and the other consists of a continuous, solid surface (e.g., tiles) on top of a substrate. Spaced deck boards are usually a combustible product, although some deck boards are made from metal or other noncombustible material. A solid surface deck can be applied over a lightweight concrete substrate or wood-based sheathing substrate, such as plywood, that has a polymer-based waterproofing membrane topping surface. The exposed walking surface can be a combustible or noncombustible material. Solid surface decks are more expensive, and therefore decks and porches made using spaced deck boards are more common. Ground-level patios often have a solid walking surface.

Decks are an important consideration because they are usually attached to a home or business and are next to a window or sliding glass (or other) access door. Consider the construction material used to build the deck, patio or porch, along with the furniture and other items that are on it and stored beneath it. This area is part of your defensible space and therefore it is also necessary to consider vegetation leading up to the deck. This is particularly important for decks attached to a home or business that is located on a sloped lot. Depending on the type and condition of the vegetation, flame lengths on a slope can reach more than 30 feet, increasing the likelihood of a flame contact exposure to the underside of an elevated deck when vegetation in this region isn't managed.

It is common knowledge that wood deck boards are combustible. There is sometimes a misunderstanding regarding the combustibility of plastic and wood-plastic composite decking products—these decking products are also combustible.

California has established performance requirements in the building code for combustible decking products. Information about these products are included in the Building Materials Listing Program managed by the California Office of the State Fire Marshal.

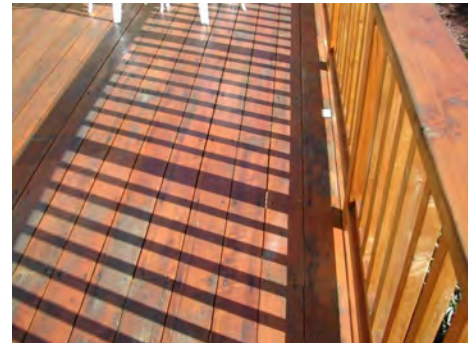
For information about deck boards that comply with the California requirements, see osfm.fire.ca.gov/licensinglistings/licenselisting_bml_searchcotest.php.

Select “8110—Decking for Wildland Urban Interface (W.U.I.)” from the “Category” drop-down menu and then click the “Search” button.

Wood decking products that have been treated with an exterior-rated fire-retardant chemical are commercially available, but untreated nominal 2-inch redwood and western red cedar will comply with the building code requirements, so use of a fire-retardant-treated solid wood product is not necessary to comply with the California requirements. All deck boards complying with these requirements will have a stamp or label on each board. San Diego County has adopted requirements for decking that are considered by many to be more restrictive than those adopted by the state.



A deck with a lightweight concrete (noncombustible) walking surface. Source: firecenter.berkeley.edu/bwmg/decks-1.html



A deck with wood (combustible) deck boards. Source: Stephen L. Quarles



A small deck on a house located at the top of the slope. Source: Stephen L. Quarles



Recent testing at the IBHS Research Center indicated that lower-density wood, such as redwood, was more vulnerable to ignition by wind-blown embers relative to a higher-density wood-plastic composite product. Higher-density wood, such as the tropical hardwood ipe, and exterior fire-retardant-treated deck boards were also less vulnerable than a lower-density wood decking product. All of these experiments were conducted without between-deck-board debris accumulation. Ember ignition of the debris would result in a flaming exposure to the deck boards. Previous experiments have shown that non-Chapter 7A deck boards can be vulnerable to a flaming contact exposure.



Wind-blown ember accumulation in deck board gaps at locations where deck boards intersected with the wood joists resulted in ignition of the deck boards.

Embers that accumulate on top of the deck can pass through the gaps between deck boards. Finer fuels, such as pine needles, can be ignited by these embers.



Embers passing through gaps between deck boards can ignite fine fuels that can accumulate under the deck, providing further evidence for the need to remove combustible materials from under the deck.



Wind-blown ember accumulation in deck board gaps at locations where deck boards intersected with the wood joists did not result in ignition of the higher-density wood-plastic composite deck boards.



Some checklists and guides suggest attaching a corrosion-resistant metal flashing strip between the top of the deck and extending up the exterior combustible siding. The purpose of the flashing would be to provide protection from ember accumulation next to the wall—both the embers themselves and the flaming exposure that would occur if accumulated debris at the deck-to-wall intersection were ignited by the embers. This is a good idea, as long as the flashing is tucked in behind the siding where the top of flashing terminates (called “letting in”) to prevent water from entering the space between the flashing and the siding. Once inside this space, water cannot drain out and could lead to the rotting of a wood or wood-based siding product. The recommended height is a minimum 6 inches. Higher would be better, but even a 6-inch strip (or width of one piece of siding) would reduce the vulnerability of a combustible siding product. As an alternative, if you can find a close match in terms of siding pattern, the bottom two or three courses of a combustible siding product could be replaced with a noncombustible product.

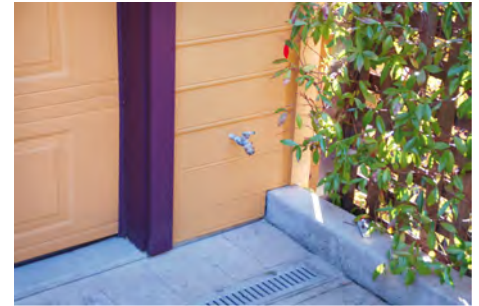
The area under your deck should be treated as part of your noncombustible zone. If you have a spaced-board deck, and absolutely must store some combustible materials under your deck, enclosing it can help reduce the risk of damage from wildfire. Decks and porches can be enclosed vertically by applying an exterior siding product around the perimeter, or enclosed horizontally by applying an exterior panelized product to the bottom of the support joists. Deck enclosure, however, brings with it the possibility of moisture-related degradation of wood structural support members and metal fasteners if proper drainage and ventilation is not provided.

WHAT YOU SHOULD DO

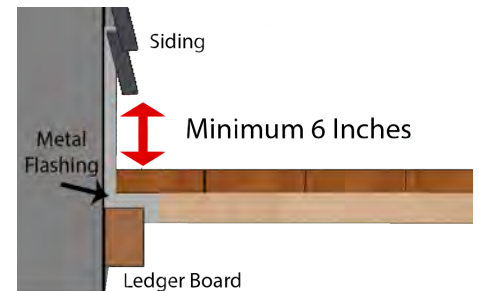
If you choose to enclose your deck or porch, with the exception of screens, make sure you provide sufficient ventilation to avoid the accumulation of excessive amounts of moisture. If you do not allow for the drying out of the structural support members and boards, fungal decay and corrosion of metal fasteners will become the biggest threat to your deck. The building code requirement for a crawl space is 1 square foot of vent area for each 150 square feet of horizontal floor area. You should have at least this much ventilation, or more if you are in a particularly wet area. Use of a fine mesh screening as “cladding” for a vertical enclosure would allow for ventilation and minimize entry of embers and wind-dispersed vegetative debris. Laboratory research has shown that embers large enough to pass through ¼-inch and even ½-inch screens are large enough to ignite fine fuels, so while screening will help, it won’t be the perfect answer.

Enclosing your deck or porch will not reduce the risk of the top being exposed to embers. For that, the best protection is to keep the surface clear of leaves, pine needles and other vegetative debris. Higher-density deck boards (including wood-plastic composite and tropical hardwood deck boards) are more resistant to direct ember ignition.

Move combustible materials such as furniture cushions, brooms and door mats inside. Smaller furniture, such as chairs, should also be moved inside, particularly wicker furniture, which could be more easily ignited by embers.



A noncombustible lower course of siding was used in this installation with otherwise combustible siding used in the higher courses. Source: Stephen L. Quarles



Metal flashing could be used to protect combustible siding from an ember exposure. To avoid moisture-related degradation problems, the flashing should be tucked behind (“let in”) the siding at a lap joint.



A horizontal enclosure, such as that shown here, can result in moisture-related degradation of wood and metal fasteners when deck boards are used.



To determine if enclosing your deck would be beneficial, consider whether your vegetation management plan is inadequate, particularly in the 0- to 30-foot zone. If you avoid storing combustible materials underneath and if you create and maintain an effective defensible space with your vegetation management plan, enclosure is not as important. If you live in a grass or brush area, and if your deck overhangs a very steep slope, building a noncombustible wall within approximately 20 feet from the deck would help deflect the flames of an uphill burning fire. As recommended in NFPA 1144 (Standard for Reducing Structure Ignition Hazards from Wildland Fire), these walls should be about 6 feet tall. If you live in a forested or wooded area, making sure the trees are thinned and limbed up, to minimize the opportunity for any fire to move into the tree crowns, would be the best solution. A crown fire in the trees will be able to burn over the top of a 6-foot wall.

SIDING

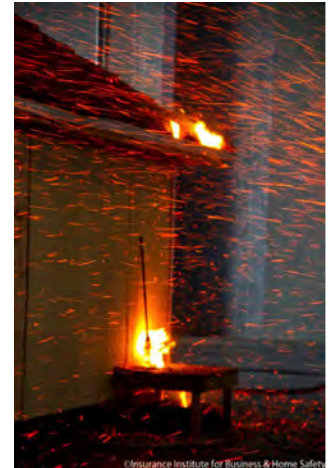
WHAT YOU SHOULD KNOW

Siding can be vulnerable for two reasons. First, if ignited, combustible siding can provide a path for flames to reach other vulnerable components of your home or business, such as a window or the under-eave area. Second, if penetrated, a horizontal or vertical lap joint will provide access for flames to enter the building. Combustible siding products are more vulnerable than noncombustible products to the penetration of flame at lap joints.



Vertical flame spread on the combustible siding product on the left-hand side of the corner section. The siding material on the right-hand side was a noncombustible product. A burning wood crib was the initial exposure for both wall sections. Source: firecenter.berkeley.edu/bwmg/siding-2.html

California uses a standard test procedure to evaluate the ability of a product to resist the penetration of fire, either at a horizontal or vertical lap joint, or in the field of the siding away from a lap joint. Combustible siding products that meet the requirements of this test comply with Chapter 7A. These products are included in the Building Materials Listing Program (more information is provided later in this section).



The broom on this test deck was ignited by wind-blown embers. Note that the embers also ignited pine needle debris in the gutter.



Flames from a gas burner on the opposite side of the wall resulted in flame penetration through a lap joint and into the stud cavity. The State Fire Marshal test method for combustible siding products consists of a flame impingement exposure, similar to that used in this test. As built, this siding product would not comply with Chapter 7A requirements. Source: firecenter.berkeley.edu/bwmg/siding-2.html



Fire-retardant coatings, usually an intumescent type, that have been developed for interior use are sometimes suggested for use in exterior applications, either applied as a primer or top coat, on products such as siding. While these products may work well in interior applications, they tend to lose effectiveness when used in exterior locations. The use of coatings as fire retardants should be avoided in exterior exposures until adequate information regarding performance after weathering has been demonstrated.

Large wood members, such as those used in log houses, are more difficult to ignite and resist penetration of fire better than the more typical smaller dimension wood siding products. The most vulnerable part of a log wall is arguably the between-log joint. Vulnerability in this area is minimized if the joint is chinked with a fire-resistant material that provides protection from flame penetration or if a more complicated (usually machined) between-log joint is used. Similarly, a wood siding product with a tongue-and-groove or shiplap joint offers better resistance to flame penetration into the stud cavity than other bevel-type joints. Incorporating an underlying sheathing panel into the wall assembly will improve the ability of any siding material to resist fire penetration at a lap joint. Sheathing is commonly used in California construction for structural reasons.

Vinyl siding will deform and fall off the wall at relatively low radiant heat or flame exposures. If this happens, protection of your home or business will depend on the performance of any underlying material.

Noncombustible siding, including fiber-cement, traditional three-coat stucco, and brick can provide the best protection. Wood siding that has been treated with an exterior-rated fire-retardant chemical will also improve the performance of siding against both radiant heat and flame contact exposures.

Materials that comply with the Chapter 7A requirements can be found at the following site maintained by the California Office of the State Fire Marshal:

osfm.fire.ca.gov/licensinglistings/licenselisting_bml_searchcotest.php

Select “8140—Exterior Wall Siding and Sheathing for Wildland Urban Interface (W.U.I.)” from the “Category” drop-down menu and then click the “Search” button.

WHAT YOU SHOULD DO

If you have combustible siding, incorporating a noncombustible or low-combustible zone next to your home or business would reduce the vulnerability of your siding. If you have a chinked-style log home or business, inspect the chinking for cracks and missing pieces. Repair and replace with fire-rated chinking.

If you have a concrete foundation, either slab-on-grade or raised-floor (crawl space), you can help protect your combustible siding from debris that accumulates by making sure you maintain the code-required ground-to-siding distance of 6 inches (required for all wood-based siding).

Replacing siding is expensive. Except where combustible siding is used on vertical walls on complex roofs, other less expensive items that are discussed in this guide, such as use of metal flashing and careful attention to the vegetation management in the area immediately adjacent to your home, will enhance protection.



Deformed vinyl siding from a radiant heat exposure from a nearby burning home. Source: Stephen L. Quarles



Clearance between the ground and the start of the siding should consistently be at least 6 inches.



Replacing siding “locally,” in areas where it meets the roof on a complex roof design, such as that shown here, would be more affordable than “global” replacement. Source: Stephen L. Quarles

FENCES

WHAT YOU SHOULD KNOW

Your fence can be a hazard if it connects directly to your home or business. The bottom of fences can collect debris, which when combined with combustible fencing material, can become a fuel source that can result in fire burning directly to the building. Similar to a burning building or burning vegetation, burning fencing will also generate embers that can cause other ignitions. Ember ignitions more easily occur where a horizontal member meets a vertical member. Subsequent spread to the building is facilitated when combustible debris is on the ground below the fence. For combustible fencing materials, designs with more between-member openings or gaps (i.e., it is more porous), such as a lattice fence, make it more difficult for lateral flame spread to occur.

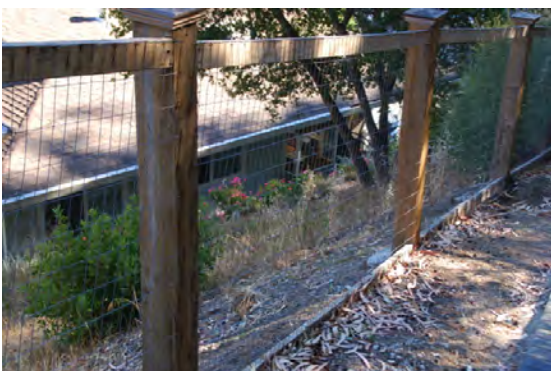
Some checklists recommend inserting a metal plate where the fence connects to the exterior wall of a building, particularly when combustible siding is used. How effective the flashing will be will depend on the size of the metal strip. Depending on how it is attached to the exterior wall, over time it could result in other moisture-related degradation problems with the siding. For example, without appropriate attachment, water will be able to get behind the flashing and will likely be absorbed by wood siding; over time, decay of the wood siding or corrosion of the fasteners could occur.

WHAT YOU SHOULD DO

New fences should be constructed of noncombustible or ignition-resistant materials. The most common product meeting the ignition-resistant material requirements is exterior-rated fire-retardant-treated wood. 4-inch by 4-inch (or larger) support posts intended for ground contact use should be treated with a preservative—wood treatments for both a fire retardant and preservative are not available. Another option would be to attach the wood column to a concrete footing using a metal connector, avoiding a ground contact exposure for the column.

A wood frame with steel mesh infill is an option that would minimize the possibility for an ember ignition; however, if vegetation is allowed to grow on the mesh infill, this advantage will be negated. Existing wood fences that are attached to the home or business should be modified so that the fence ends with a noncombustible component, such as masonry or metal, to minimize the chance of fire spreading to the home or business. A common technique is to use a metal gate with one side attached to the combustible fence and the other to the exterior siding.

It is important not to store firewood or other combustible materials against the fence and to regularly clear away debris and dead vegetation at the bottom of the fence.



Wood frame fence with metal mesh infill. Debris accumulation at base of fence, against the wood lateral member, would make that member more vulnerable to an ember ignition, and increase the opportunity for fire to spread laterally. Source: firecenter.berkeley.edu/bwmg/attachments-1.html



Ignition from ember accumulation most easily occurred at the intersection of the vertical planks and the horizontal lumber.



Flame spread to the building occurred more easily when combustible debris was present at the base of the fence, as shown here.



A gate made from noncombustible materials should be used where a connection is made to the house. Source: firecenter.berkeley.edu/bwmg/attachments-1.html



CHIMNEYS, BURN BARRELS AND OPEN DEBRIS BURNING

Many wildfires are caused by human activities. Reducing the number of wildfires and losses begins with taking precautions to reduce this cause of fire.

WHAT YOU SHOULD KNOW

Spark arrestors reduce the size of embers that can escape from your chimney.

The spark arrestor concept also applies to burning debris and garbage in an open barrel. Embers generated during burning can result in ignitions in adjacent woodlands. Fire can also escape when doing debris burning in open piles.

WHAT YOU SHOULD DO

Install a spark arrestor that has a ½-inch mesh size. These are available at lumber yards, hardware stores and fireplace specialty stores.

In the case of burning in barrels, a heavy metal screen with ½-inch mesh should be placed on top of the barrel. Debris should also be cleared from the area immediately surrounding the barrel. Care should always be taken when conducting open backyard debris burns to minimize the chance that the fire escapes. State and local ordinances may require a permit for open burning. Contact your local fire department for additional information, particularly for information regarding any restrictions on use of burn barrels.

Follow these guidelines from CAL FIRE for safe debris burning:

- Clear a safe zone that is wide enough to prevent the escape of fire
- Keep a supply of water and a rake or shovel readily accessible
- Stay with the fire until it is completely out and never leave a fire unattended
- Burn only when the wind is calm and the humidity level is high
- Extinguish fire completely if conditions become windy
- Keep brush piles small to allow quick control of the fire if necessary
- Locate brush piles an adequate distance from buildings and utilities
- Obey all outdoor burning laws including forest fire laws, air pollution and open burning regulations, and local ordinances
- Understand that you are liable for damages and cleanup if the fire escapes



A spark arrestor at the top
of a chimney.



VEGETATIVE FUELS TREATMENTS AWAY FROM BUILDINGS

WHAT YOU SHOULD KNOW

Major vegetation (fuel) types in wildland areas of California include mixed conifer forests and woodlands, brush and shrubs, such as chaparral (examples of chaparral species include chamise and manzanita).

Fuels reduction treatments in forested areas, away from homes, have been shown to reduce the wildfire hazard since mechanical treatments, where selected trees and other vegetation are removed or ground-up and deposited in the ground, and prescribed fire can result in wildfires that burn largely as surface fires. When crown fires burn into a thinned and treated area, the fire will drop to the ground. Fuels treatments are more qualified in effectiveness in Southern California chaparral (shrub lands). Chaparral has only one strata and therefore fire can easily result in a crown fire. Wind-blown embers from fires in chaparral can ignite spot fires in advance of the wildfire, making fuels treatments less certain. For these reasons fuels treatments are more commonly implemented in forested areas and may not be implemented as much in chaparral. Fuels treatments in chaparral have been reported to be effective near communities, similar to that reported for forested areas.

The home and business owner should remember that vegetation and fuels treatments around the home or business is useful and effective regardless of the particular wildland vegetation in the area (i.e., it will be useful whether located in a mixed conifer or chaparral wildland area).

WHAT YOU SHOULD DO

If your community hasn't done so already, work with your community leaders to create a Community Wildfire Preparedness Plan (CWPP), one step in preparing your community for wildfire. Learn more about preparing for wildfire by participating in or initiating educational programs such as Fire Adapted Communities (www.fireadapted.org), or programs such as Firewise (www.firewise.org) and, in the Lake Tahoe Basin, the Living with Fire Program (www.livingwithfire.info).

CREATING DEFENSIBLE SPACE

WHAT YOU SHOULD KNOW

Identifying Fuels Management Zones

There are several kinds of fuels management (or modification) zones. These include defensible space around a home or building, community fuel breaks, fuels treatment along an access road (reducing the chance of rapid fire spread from ignition by a passing vehicle or equipment), and those used to create a community safe area. In this document, the discussion of a fuels management zone will be limited to the general objectives of preparing and maintaining defensible space around a building and those to create and maintain a similar zone around a community, such as around a community center. The term "fuel" is broadly defined



Forested area in northern California after a wildfire. Trees with foliage in background indicates previous fuels treatments resulted in the crown fire dropping to the ground. Source: Stephen L. Quarles



Fuels treatment in chaparral, showing a planned community fuels treatment project.



A fuel break along a rural highway in northern California. Source: Stephen L. Quarles



and includes vegetation surrounding a building or community. When discussing defensible space around a building, it would also include other combustible materials such as firewood and building materials that are often stored outside. Fuels modification and management includes actions taken in terms of selecting, locating and maintaining vegetation and decisions regarding storage of combustible items to reduce or otherwise modify the fuel loading on the property. These are critical components to making and maintaining effective defensible space. For this document, the principal objective of fuel modification and reducing fuel loading is to minimize the ability of the flame front of a wildfire to burn to the building, and reduce the opportunity for vegetation ignited by embers to create a flame contact and/or sufficient radiant exposure to ignite or damage the building.

Defensible Space

The term “defensible space” refers to the area between a building and an oncoming wildfire where vegetation has been managed to reduce the wildfire threat to the home or business.² Although some definitions of defensible space include a safe area for firefighters to defend the building, this document will focus on the use of defensible space to reduce the fire threat to the building so that it can have a better chance of surviving without suppression activities by firefighters. During most wildfire conflagrations, firefighters may or may not be available based on conditions and other fire activity.

Defensible space around a home or business is divided into two or three zones. In California, including Chapter 7A, two zones are used. These zones include: (1) the “lean, clean and green” zone, which starts at the perimeter of the building and extends outward 30 feet, and (2) the reduced fuel zone, which extends from 30 to 100 feet or to the property line (whichever comes first). Some defensible space recommendations include a third zone that incorporates the space from 0 to 5 feet from the building perimeter. This zone is called a noncombustible (or low combustibility) zone. Although not officially required in California, it is recommended by several outreach and education groups, including IBHS, Nevada’s Living with Fire Program, and the NFPA Firewise Program. This zone will be included in the discussion in this document.



A representation of three defensible space zones, including the 0–5 feet zone (“near-building,” “noncombustible,” or “low-combustible” zone).

² (Fire Adapted Communities: The Next Step in Wildfire Preparedness, University of Nevada Cooperative Extension, Publication SP-10-10)



WHAT YOU SHOULD DO

Create and maintain an effective defensible space on your property using the information provided below.

ZONE 1: 0–5 FEET (Near-Home Noncombustible Zone)

WHAT YOU SHOULD KNOW

The objective of this zone is to reduce the chance that ignition will occur near the home and result in a direct flame contact exposure to the building. Because this zone is closest to the building, it requires the most careful selection and intensive management of vegetation and materials.

WHAT YOU SHOULD DO

Install hard surfaces in this zone (e.g., concrete walkway) or use noncombustible mulch products (e.g., rock mulch). Landscape vegetation recommended for this zone includes irrigated lawn and low-growing herbaceous (non-woody) plants. Shrubs and trees, particularly conifers, are not recommended for use in this zone. Remove dead plant material from plants. Plants adjacent to combustible siding and foundation vents, as well as plants under or next to windows and soffit vents or interior corners, present the greatest hazard.

ZONE 2: 5–30 FEET (or to the property line, referred to as the Lean, Clean and Green Zone)

WHAT YOU SHOULD KNOW

The objective of vegetation management in this zone is to prevent the fire from climbing into the crown or upper portions of trees or shrubs and to stop the fire from burning directly to the building.

CAL FIRE Office of the State Fire Marshal and Nevada's Living with Fire program recommend that a relatively small amount of vegetation be present in this area. Dead vegetation and combustible debris is eliminated. Vegetation in this area is typically irrigated, and incorporates ornamental plants that are maintained, consistent with common residential landscapes (from www.livingwithfire.info).

Paved parking areas surrounding commercial developments can serve as fire breaks, stopping the fire front from burning directly to the buildings. Embers may still be able to ignite individual islands of plants in this zone, and that is why plant selection and maintenance is so critical in the 0–5 foot zone.

WHAT YOU SHOULD DO

Trees and shrubs in this zone should be in well-spaced groupings and well maintained. Eliminating ladder fuels and creating separation between plants or plant groupings are techniques used to fulfill this objective.

Dead plant material and tree branches should be removed from vegetation on a regular maintenance schedule.



A noncombustible zone around a home in the Lake Tahoe Basin. In this case, requirements related to water runoff and protection from wildfire align.



ZONE 3: 30–100 FEET (or to the property line)

WHAT YOU SHOULD KNOW





The objective of vegetation management in this zone is to slow down and reduce the energy of the wildfire and slow its advance to the building. Tree and brush spacing should force any fire in the tops of the trees, brush or shrub crowns to drop to the ground.


The rate of spread and flame length of a wildfire is affected by slope. A steeper slope will result in a faster-moving fire with longer flame lengths.

WHAT YOU SHOULD DO

Dead plant material and tree branches should be removed from vegetation on a regular maintenance schedule. Creating islands or groupings of vegetation creates a discontinuous path of vegetation, thereby making it difficult for the fire to burn directly to the building. Lower tree branches and nearby shrubs (the ladder fuels) should be removed so that a surface fire cannot reach the tree crown. Recommendations for vertical and horizontal separation distances have been provided by CAL FIRE (see figures on next page). Trees located within this area should be maintained with a minimum horizontal spacing of 10 feet between crown edges, with adjustments as a function of slope. From the perspective of tree health, branch removal should not exceed $\frac{1}{3}$ of the tree height. Note that whereas CAL FIRE provides a formula to determine minimum vertical clearance between top of shrub and the lowest tree branch, some jurisdictions recommend that shrubs be removed from the area under the drip line of the tree or tree grouping.

Determine the slope of the land around the building. For new construction, the building should be set back a minimum of 15 feet from the edge of the slope for a single-story building and 30 feet for a two-story building. Buildings located mid-slope, or with inadequate setback at the top of slope, should utilize an enhanced fuel modification zone, sometimes recommended up to 150 or 200 feet for slopes greater than 40%. Locate outbuildings (e.g., for storage) at least 30 feet away from the building or create defensible space around the outbuilding.

Minimum Horizontal Clearance	
SHRUBS	TREES
<p>From edge of one shrub to the edge of the next</p> <p>Flat to mild slope (0% to 20% slope) Two times (2x) the height of the shrub (Two shrubs 2' high should be spaced 4' apart)</p>  <p>10 feet</p>	<p>From edge of one tree canopy to the edge of the next</p> <p>Flat to mild slope (0% to 20% slope)</p>  <p>10 feet</p>
<p>Mild to moderate slope (20% to 40% slope) Four times (4x) the height of the shrub (Two shrubs 2' high should be spaced 8' apart)</p>  <p>20 feet</p>	<p>Mild to moderate slope (20% to 40% slope)</p>  <p>20 feet</p>
<p>Moderate to steep slope (greater than 40% slope) Six times (6x) the height of the shrub (Two shrubs 2' high should be spaced 12' apart)</p>  <p>30 feet</p>	<p>Moderate to steep slope (greater than 40% slope)</p>  <p>30 feet</p>

Minimum Vertical Clearance	
3X HEIGHT OF SHRUB = MINIMUM VERTICAL CLEARANCE	
<p>Example: A five foot shrub is growing near a tree. $3 \times 5 = 15$ feet of clearance needed between the top of the shrub and the lowest tree branches.</p>	 <p>3x height of shrub to lowest branches of tree.</p>

Estimation of clearance distances. Source: CAL FIRE. (2007)
Why 100 Feet? [Brochure]



FIREWOOD, LEFTOVER MATERIALS AND COMBUSTIBLE MATERIALS

WHAT YOU SHOULD KNOW

Firewood, combustible mulch or other combustible materials located near the home or business can spread the wildfire to the building. Mulch offers several beneficial attributes to the soil, including water retention and weed and erosion control, but many mulch products are combustible.

The ease with which combustible mulches ignite and the speed with which fire will spread will depend on the characteristics of the particular mulch—but they will all burn. Smaller mulches or ones that have fine fuel components (e.g., the hairy bark or needle mulches) will ignite and spread fire more quickly. Studies have shown that composted mulches perform better than other combustible mulches, but even this material exhibits smoldering combustion. Noncombustible mulch products are available and should be considered for use in the 0–5 foot zone. Since noncombustible mulches do not break down, they do not add to soil fertility and improve soil structure, but they do provide other attributes (e.g., they minimize soil compaction, moderate soil temperature, and limit germination and growth of weed seeds).

WHAT YOU SHOULD DO

Carefully balance the benefits of mulch with the potential hazard in terms of spreading fire to the building. Do not use wood, bark or rubber mulch products in the zone immediately adjacent to the home or business, particularly small pieces of bark or those with hairy components such as “gorilla hair” mulch. Use noncombustible rock mulches in the area immediately adjacent to your home or business. Move firewood and combustible building materials as far away as possible from your home or business. Firewood piles should be located at least 30 feet from any building on the property.

PLANTS

WHAT YOU SHOULD KNOW

There are several factors that influence the fire characteristics of plants.

1. Plant age
2. The amount of dead material in the plant (which will influence the overall moisture content of the plant), often related to plant age
3. The surface-to-volume ratio of the plant components (i.e., needles have a larger ratio than twigs, which in turn have a larger ratio than branches; needles are easier to ignite than twigs, and twigs are easier to ignite than branches)
4. The geometry (i.e., the shape of the plant and how the biomass is distributed)
5. The total volume
6. The chemical content (i.e., the amount of volatile chemicals)



Burning rubber mulch during an experiment that evaluated various combustible mulch products.
Source: Stephen L. Quarles

7. Plant maintenance (lack of maintenance or inadequate maintenance can increase the fire hazard of a plant or landscape)

See “Additional Resources” section at the end of this document for more information.

Woody plants located close to the building can be a major fire hazard, which is why they are discouraged in this guide. Plants adjacent to combustible siding, as well as plants under or next to windows or the interior corners of a home, present the greatest hazard. Embers from a wildfire can reach the home or business from a mile or more away, and can become trapped in corners, at the base of walls and on the roof, igniting nearby plants and exposing siding and the roof overhang to flames.

WHAT YOU SHOULD DO

Carefully maintain your landscape vegetation. Remove dead vegetation closest to your home or business, paying attention to material on and underneath plants. In the areas immediately adjacent to your home or business, select non-woody low-growing herbaceous vegetation. For plants, shorten the height, remove branches that are close to the ground, prune to reduce the amount of material in the plant and remove dead material.

YARD AND GARDEN STRUCTURES

WHAT YOU SHOULD KNOW

Arbors, pergolas or trellises, combustible fencing, playground equipment, gazebos and other structures located close to your home or business will increase its vulnerability to wildfire. Wind-blown embers can accumulate in or on such structures and ignite them. Depending on how close the items are to the building, they might act as a fuel source, resulting in the ignition of your home or business, either as a result of flame contact or exposure to radiant heat. Trellises and pergolas are especially susceptible, since they are often made of wood or other combustible materials, and are typically covered with vegetation and attached to or adjacent to the building.

Play sets located near the home should be treated like gazebos, tool sheds, and other structures. If ignited, and if close enough to the home, they will create a radiant heat exposure. When determining the potential threat from your play set, consider the material used to construct it and the “surfacing material” (the type of material under and around it). Typically, wood play sets use larger and therefore harder-to-ignite members. The more easily ignited wood chips, and rubber-based surfacing materials surrounding the play set, may pose a greater threat to your home than the play set itself.



Vegetation growing over a trellis structure. If ignited, flames would impinge on the side of the house, including the nearby gable end vent. Source: Stephen L. Quarles



WHAT YOU SHOULD DO

Consider removing arbors or pergolas made from combustible materials. Structures made from metal would be acceptable choices. Wood arbors and pergolas can be more resistant to fire if they are made with exterior-rated, fire-retardant lumber or larger dimension material. If you go this route, you should also use the heartwood of a naturally durable species (such as redwood or cedar). A treatment for lumber that can function as both a fire retardant and a preservative against wood-destroying organisms isn't currently available. Remember that wood members with smaller cross-sections ignite and burn more easily. You could also consider mixing materials—using larger timbers for the supporting structural members and choosing non-combustible materials for the smaller members of the structure. Keep all yard structures free of accumulated debris.

Any structure, such as a child's play set or gazebo, using a combustible surfacing materials should be relocated at least 30 feet away from the home.

OUTBUILDINGS, FUEL TANKS AND OTHER COMBUSTIBLES

WHAT YOU SHOULD KNOW

All buildings on the property face the same types of risks when it comes to wildfire. If ignited, outbuildings will burn much longer than a typical plant, resulting in a longer fire exposure for other buildings on the property. They will also generate their own embers. Boats, RVs and other personal property can also burn intensely. They should be protected inside a building or parked at least 30 feet from the home or business.

If flames come too close to exterior liquefied petroleum (LP) tanks, or if they are exposed to an extended radiant heat exposure, the pressure relief valve may activate as a result of the increasing internal pressure in the tank. This may result in ignition of the escaping gas and the resulting column of flame. Flame impinging on the upper surface of the tank, or an extended high-level radiant heat exposure can also result in an explosion, particularly when the fuel level is lower. As the temperature of the tank increases, the strength of the steel decreases; the explosion (called a Boiling Liquid Expanding Vapor Explosion or BLEVE) occurs when the internal pressure exceeds the strength of the steel.

It is important to follow your local building code requirements regarding tank placement, particularly smaller vertical cylinders located near the building that have restrictions with regard to proximity to wall vents and windows. Larger propane tanks (greater than 500 gallons water capacity [w.c.]) should be located at least 30 feet from your home or business.



A wood play structure. Note the larger wood members in this play structure. The bark mulch used for the surfacing material pose a bigger threat in terms of ease of ignition from an ember exposure. Source: Stephen L. Quarles



WHAT YOU SHOULD DO

Locate combustible outbuildings at least 30 feet away from your home or business. Other options would be to create defensible space around the outbuilding or to incorporate noncombustible or ignition-resistant materials into the building's construction.

If necessary, relocate the propane tanks at least 30 feet from your home or business. Create a noncombustible zone within 10 feet of the tank. Another option is to enclose the tank. If an enclosure is used, it should be made of noncombustible materials (i.e., fiber-cement siding, concrete block, stucco or brick). Smaller (vertical) LP tanks that are (by code) allowed to be positioned near the home should be placed on a noncombustible platform or surface.

IMPORTANCE OF TOPOGRAPHY

WHAT YOU SHOULD KNOW

Wildfire-prone areas in California are also associated with canyons, hilltops and valleys. These features can present a greater fire hazard to your home or business. The topography around your home or business, which includes the slope of the land and the direction the building faces, is a major consideration in assessing the potential fire hazard. Wildfires burn up a slope faster and more intensely than along flat ground. A steeper slope will result in a faster-moving fire with longer flame lengths.

WHAT YOU SHOULD DO

Determine the slope where your home or business is located. Select a mark on the slope and walk 10 paces downhill. If your head is below the mark, you have a steep slope.

If your home or business is mid-slope or at the top of a steep slope, and set back less than 15 feet for a single-story house or 30 feet for a two-story house, take additional precautions. These include being more aggressive with your vegetation modification and maintenance plan and being more aware of the materials used to build the house, deck or any outbuildings. You will also want to push the fuel modification area beyond the 100-foot length, if at all possible. A target for the extended fuel modification area would be between 150 and 200 feet.

Consider increasing the protection of your home or business by constructing a noncombustible retaining wall to help increase the setback. This wall should be about 6 feet tall and located about 20 feet from your home or business. As indicated in the "Deck" section of this guide, if you live in a forested area, making sure the trees are thinned and lower branches are removed to minimize the opportunity for any fire to move into the tree crowns is the best solution. Any crown fire will be able to burn over the top of a 6-foot wall. When making future improvements, incorporate ember-resistant features and ignition-resistant or noncombustible materials into the home or business and surrounding landscape.



Poor defensible space near a propane tank. Ignition of this vegetation would provide a longer exposure to heat. Depending on level of fuel in the tank, an explosion would be possible under this scenario.



A prescribed burn in chaparral in northern California. Source: Stephen L. Quarles



IMPORTANCE OF ENVIRONMENTAL CONDITION

WHAT YOU SHOULD KNOW

Higher wind speeds, such as those associated with Santa Ana winds in the southern part of the state or the Diablo winds in the northern part of the state, are frequently associated with fast-moving wildfires. Strong winds blowing a fire toward your home or business will have the same effect as a building being located on a slope; the fire will move faster and burn more intensely, blowing embers in front of the fire. The flame lengths also will be longer.

WHAT YOU SHOULD DO

If your home or business is located on the side of a development that faces into the prevailing strong wind direction or on a side that is parallel to the prevailing strong wind direction, consider pushing the fuel modification area beyond the 100-foot length. A target for the extended fuel modification area would be between 150 and 200 feet.

DEFENSIVE ACTIONS

WHAT YOU SHOULD KNOW

Defensive actions can consist of a number of actions that can potentially help your home or business survive a wildfire. These actions are in addition to creating and maintaining defensible space on your property and selection of appropriate building materials already discussed in this document. Examples of defensive actions include one or more of the following:

1. Installing an exterior water spray system, as part of your “before the fire” activities, and then activating when a wildfire threatens, typically just prior to evacuating.
2. Application of a gel coating to the exterior of your home or business to protect it from wildfire, applied prior to evacuation. This type of coating could also be applied by fire-fighting professionals if they are present.

Post-fire studies conducted in Australia have shown that the chance of home survival increases if the resident “stays and defends.” Evidence in Australia and the U.S. have also shown that delaying evacuation will increase the chance of harm coming to the individual(s). For this reason, we urge residents to evacuate when requested by police or fire authorities. There are situations where residents could become trapped and therefore not able to safely evacuate, so preparation for that possibility would be prudent.

More recently, evidence from post-fire studies in the U.S. has demonstrated that defensive actions taken on the part of fire-fighting professionals will also improve the chance of home survival. The latter finding is not surprising, but to reiterate what has already been stated, firefighter intervention at your home during a wildfire should not be expected.



An exterior water spray system can be roof- or ground-mounted. The objective of the sprinklers is to limit the spread of the fire to the home or business and/or extinguish wind-blown embers before they reach the building being protected. Using exterior sprinklers can help to reduce the chances of a home or business being damaged by a wildfire, but like all other actions that can be taken, it requires planning and the system must be maintained. It should also be treated as one component of a fire safe plan and it should not eliminate actions taken regarding other recommendations in this guide. It is important to understand that the effectiveness of an external sprinkler system has not been completely evaluated, although studies that have been conducted in Canada have shown that ground-mounted sprinklers can help protect a building in cases where preparation and maintenance of defensible space has been lacking. These studies have stressed that the distribution lines of the sprinkler system must be protected from radiant heat and flames. Regarding the ability of the spray system to extinguish embers before reaching the home or business, it is likely that they may disrupt the flow of the water spray and therefore may not extinguish all of the wind-blown embers before they arrive.

Gels are composed of polymers that can adsorb large amounts of water. The heat from a fire will first evaporate the water contained in the gel before it can start to heat up the substrate on which the gel is applied. Several gel products are currently commercially available and can be purchased by the homeowner. When wildfire threatens, the product would be applied to vertical and horizontal surfaces on the home or business. These surfaces include siding, windows, under-eave areas and potentially under-deck areas. Gel products would start drying out (evaporating water) soon after being applied, and would become less effective with time. Gel manufacturers provide time limits whereby their product would remain effective. These times are typically reported to be hours.

WHAT YOU SHOULD DO

If you are trapped and cannot leave

We recommend following the recommendations provided by Nevada's Living with Fire Program, shown below. This list was developed in collaboration with representatives from the fire-fighting community.

If You Cannot Leave

- ☐ If you are unable to evacuate, stay in your home during the fire. It will be much hotter and more dangerous on the outside.
- ☐ Call 911 for assistance.
- ☐ Turn on all exterior lights.
- ☐ Stay away from windows and move to an interior room or hallway.
- ☐ Do not attempt to leave until after the fire has passed and you can safely leave.
- ☐ Check for small fires inside the house and extinguish them.
- ☐ Drink plenty of water.
- ☐ Make sure you can exit the house if it catches fire.
- ☐ Fill sinks and tubs with water.
- ☐ Place wet rags under doors and other openings to prevent entry of embers and smoke.
- ☐ Once the fire front has passed, check your flowerbeds, roof, rain gutters, attic and crawl space for fires or burning embers and extinguish them.

Source: Fire Adapted Communities: The Next Step in Wildfire Preparedness. SP-11-01. University of Nevada Cooperative Extension; Living with Fire Program. 20 p.



External Water Spray System

If you are considering an external sprinkler system, check with your local fire department. They may have plans, and other suggestions. In order to maximize the effectiveness of exterior sprinklers, they should be on a stand-alone, independent water system (i.e., tank, pool or lake) and should be attached to a pressurized delivery system or use a generator for needed pumps.

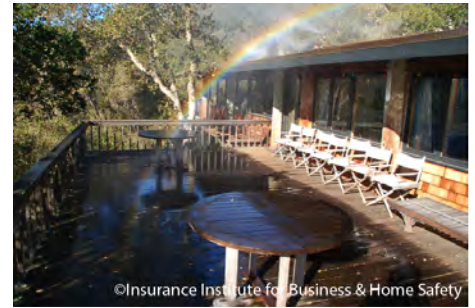
Gel Coatings

Proper application of the gel coating will be critical for it to provide adequate protection. Measure the water pressure at your house and compare to the pressure required by the gel manufacturer—inadequate pressure can reduce the effectiveness of the application. If you have a multi-level house, determine the limits of coverage on the upper elevations.

Because exposures could be from radiant heat and/or flame impingement, adequate coverage on the face of the wall (siding and windows) and under ledges (e.g., the underside of a drip edge on horizontal siding) is critical to performance of the product. As a resident, you may not have many opportunities to practice applying the product.



Application of gel to wood siding. Note that gel was not applied to the underlap area shown in center of photo. This area was close to the ground and allowed for fire to enter the stud cavity during a fire demonstration. A flame impingement source was used in this demonstration. Source: firecenterbeta.berkeley.edu/bwmg/siding-3.html



A home with an exterior sprinkler system. Note that the area immediately next to the house was not wetted by the watering system.



Application of gel coating to siding and under-eave assembly prior to a demonstration. Source: Stephen L. Quarles



ADDITIONAL RESOURCES

MARIN

Defensible Space

www.firesafemarin.org/defensible-space

Home Hardening

www.firesafemarin.org/home-hardening

Plant Selection

www.firesafemarin.org/plants



STATEWIDE

General Guidelines for Creating Defensible Space

www.bof.fire.ca.gov/regulations/proposed_rule_packages/defensible_space_2005/429145daynoticeguideline9_15_05.pdf

Office of the State Fire Marshal

osfm.fire.ca.gov/codedevelopment/wildfireprotection.php

Home Landscaping for Fire

firecenter.berkeley.edu/docs/CE_homelandscaping.pdf



Insurance Institute for Business & Home Safety
4775 E. Fowler Avenue, Tampa, FL 33617
E-mail: info@ibhs.org | Voice: (813) 286-3400
Website: DisasterSafety.org

