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Wildfire-Resilient Buildings

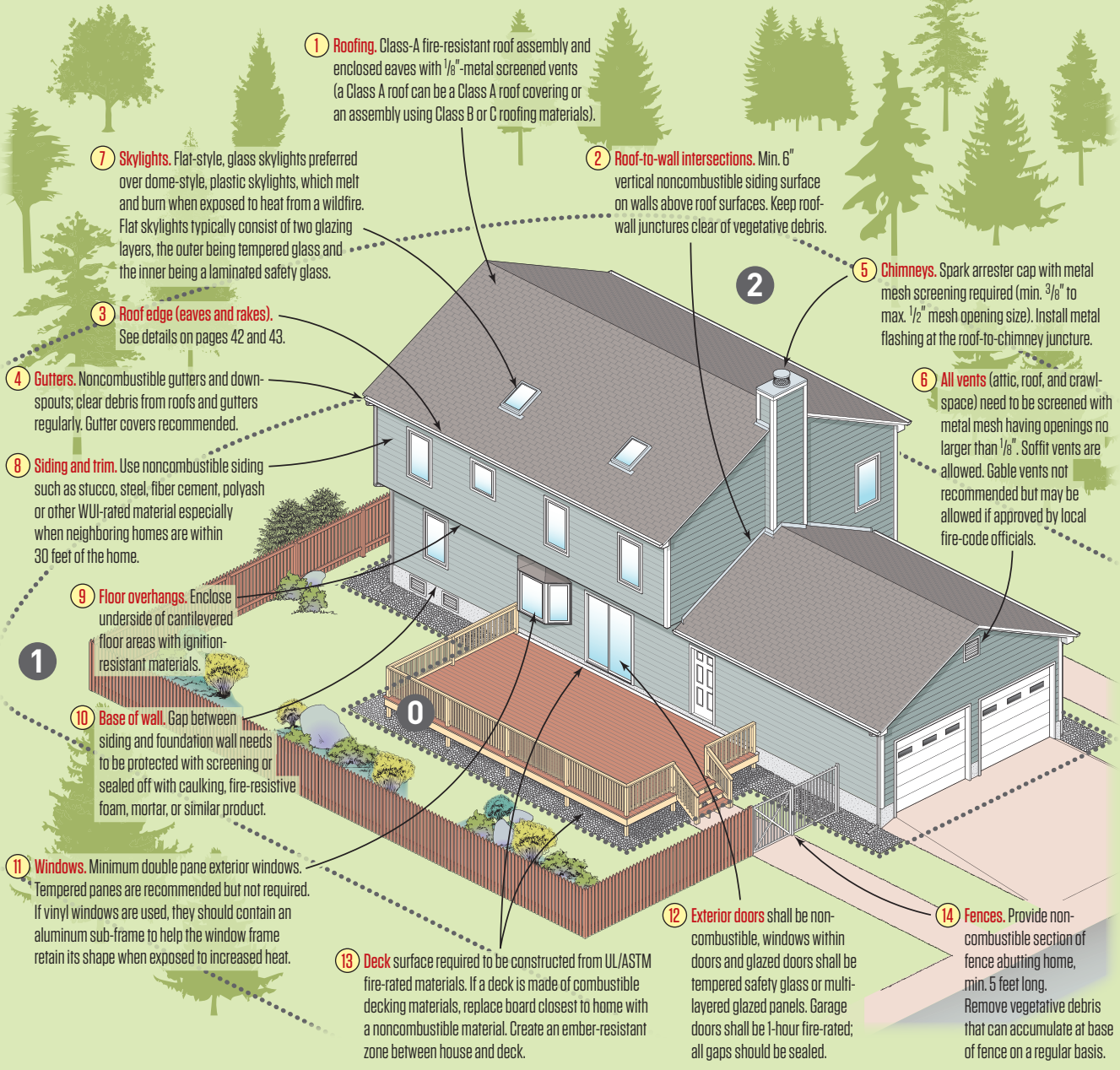
Builders hold the key to combating this growing threat

BY JLC STAFF

The Dixie Fire in California was the largest wildfire of 2021 in the U.S. It burned from July to October, consuming 963,309 acres and destroying 1,329 structures, 600 of which were homes. The Dixie Fire was the largest single wildfire in California history, but not the largest overall. That honor goes to the August Complex Fire, so named because on August 30, 2020, four fires burned together to create one massive wildfire that consumed 1,032,648 acres—an area larger than the state of Rhode Island. One person died in each of these fires. Yet, despite their vast sizes, these fires pale in terms of death and destruction compared with California's 2018 Camp Fire, which killed 85 people and destroyed 18,804 buildings, or the Tubbs fire of 2017, which killed 22 people and destroyed 5,636 buildings. And this is only in the state of California. Though the largest and deadliest U.S. fires in the last decade have all occurred there, notable fires have broken out in Washington (Carlton Complex Fire), Arizona (Yarnell Hill Fire), and New Mexico and Arizona (Wallow Fire). During 2020 alone, over 13 million acres were consumed, and nearly 15,000 buildings were destroyed in the U.S. by "large event" wildfires (those that burn more than 1,000 acres).

While none of these are the most destructive in U.S. history (compare to The Big Burn of 1910, a single fire that killed 87 people and consumed 3 million acres in the Northern Rockies in August 1910, or the 1871 Peshtigo Fire, which killed 2,500 people and burned 1.2 million acres in Wisconsin and Northern Michigan), the

Hardening Structures Against Wildfires



Defensible Space

Ember-Resistant Zone (Zone 0). 0 to 5 feet: Gravel, a concrete or brick walkway, or another hardscape feature is commonly used to construct this zone. Zone 0 should include the area under and around any attached deck. Keep zone clean of any woodpiles, wood mulch, or flammable vegetation.

Lean, Clean and Green Zone (Zone 1). 5 to 30 feet: Lean indicates that there is only a small amount of vegetation, if any, present. Vegetation should be grouped in discontinuous islands. Clean indicates that vegetative debris and dead materials are routinely removed. Green indicates that vegetation within this zone is kept green and well irrigated during the fire season.

Reduced Fuel Zone (Zone 2). 30 to 100 feet: Remove dead plant material, lower tree branches and other ladder fuels, such as shrubs, lower branches, smaller trees. Locate outbuildings at least 30 feet away from home and create an ember-resistant zone around all outbuildings and propane tanks.

Illustration adapted from "Wildfire Home Retrofit Guide" (2020), University of Nevada, Reno Extension.

1. Roofing. Homes that ignite in wildland urban interface (WUI) fires tend to burn from the top down. Class A roofing materials such as asphalt shingles, clay and cementitious tiles, and some metal roofing materials are recommended.

2. Roof-to-wall intersections are vulnerable areas because wind-blown embers will gather at the same locations where leaves, needles, and other debris have accumulated. At roof-wall junctures, install metal flashing that extends up the siding at least 6".

3. Roof edges (eaves and rakes). Use of noncombustible products for fascia, soffit, and rake trim is strongly encouraged. Open-eaves designs are more vulnerable to flames. Enclosing open eaves is recommended.

4. Gutters. Embers can ignite debris in gutters and potentially other components along the roof edge.

5. Chimneys serving fireplaces and heating appliances must have an approved spark arrester or cap. These will help minimize the possibility of sparks and embers leaving the chimney and starting a wildfire.

6. Attic vents provide an entry point for embers. Vents should be covered with min. 1/8" metal mesh screening. Finer, 1/16" mesh screening is more effective at keeping embers out but requires more maintenance to keep it debris free.

7. Skylights on steep roofs can be vulnerable to heat exposure and flame contact, particularly if nearby combustible materials ignite. Skylights on low-slope roofs are more prone to the accumulation of vegetative debris.

8. Siding and trim should consist of noncombustible or ignition-resistant material. Approved materials include, but are not limited to, fiber-cement board, polyash, stucco, masonry/brick, manufactured stone, and similar materials. Natural wood/cedar siding, hardboard, vinyl, and similar combustible materials are typically not allowed for new construction.

9. Floor projections are vulnerable to heat and embers collection. Enclosing the underside of projections with ignition-resistant products helps reduce the likelihood of ignition in these areas.

10. Base of wall. As winds and embers blow up against the foundation wall, the gap left between the siding and foundation can leave the framing or wall cavity exposed to ember intrusion.

11. Windows. Ordinary window glass may break when exposed to flames or radiant heat, allowing embers and flames to enter the home. Tempered glass is more heat resistant and, if it does break, is less likely to allow an opening for embers to enter the home.

12. Exterior doors should be constructed of noncombustible materials such as metal or composites. Wooden doors are acceptable if they are solid core construction. Sliding glass doors or decorative front doors with glass panels shall have tempered glass designed to withstand impact and meet the design standards required by building codes.

13. Deck. Wood is not permitted to be used for the decking surface but can be used for all large structural components and railings. Clear combustible debris from cracks and gaps near exterior walls.

14. Fencing. Combustible fencing can provide a direct path to a home if surrounding vegetation or embers ignite it. Separate fence from house or upgrade last 5 feet of fence to a noncombustible material. Do not use fences as a trellis for plants because plants can create and trap ignitable debris.

incidence of wildfire has increased exponentially in recent history. Though there is debate over whether the overall number of wildfires has increased, there is little debate that the intensity of, the area consumed by, and the cost of reconstruction from wildfires have grown. According to NASA, which tracks wildfire activity by satellite, the average annual number of acres burned has been steadily increasing since 1950, and the number of "megafires" (fires that burn more than 100,000 acres) has increased in the past two decades.

All of this has deeply influenced wildfire safety policy in the U.S. Traditionally, the recommendation to protect homes was to create "defensible space"—an area of landscaping with little combustible material surrounding a home—so fires would not have a chance to reach the building. (Note: The specific zones that define "defensible space" around a home vary. The illustration at left details the three zones that are commonly recommended mostly outside California. The California Building Code has a more stringent definition that includes a zone clear of combustible material that extends 30 feet around the house, an area of low, clumped vegetation extending from 30 to 70 feet, and a reduced fuel area from 70 feet to the property boundary. These stricter requirements have also been adopted outside California, just not as frequently as those shown on the facing page.)

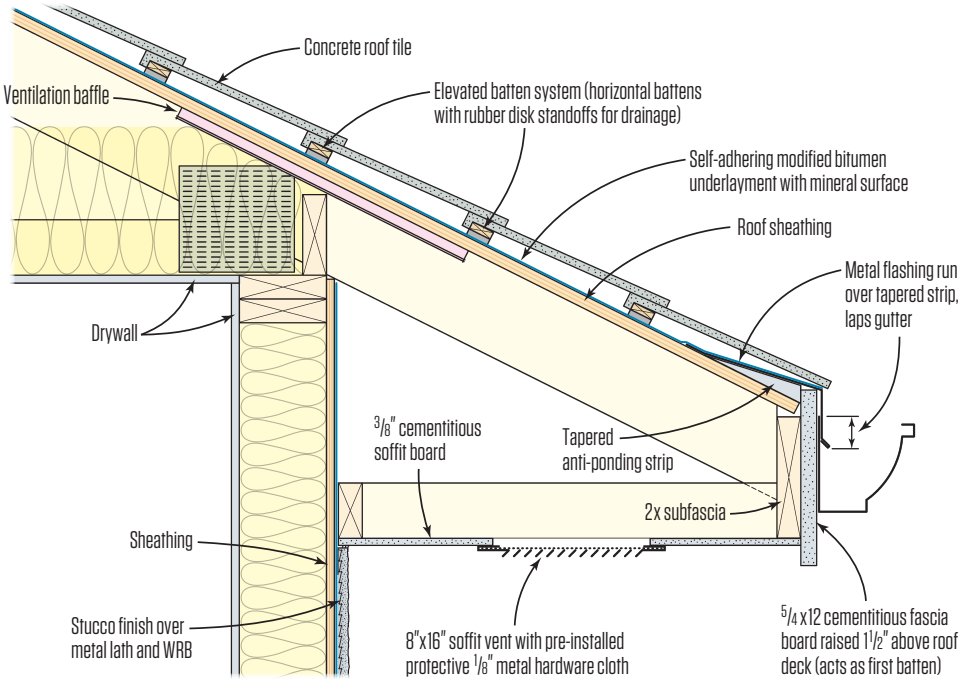
While defensible space is still a primary strategy for protecting homes, it has proven less effective for two reasons: The first is the increase in the concentration of homes in developments. Smaller lot sizes mean homes often don't have sufficient room to create much defensible space around them. Second, the increase in the intensity of wildfires has made blowing embers, which can travel distances measured in miles, a primary cause of ignition for building fires. These days, the prime strategy involves the hardening of homes to resist damages.

WE KNOW HOW TO DO THIS

According to a 2018 study published by the National Academy of Sciences, the number of homes in the U.S. wildland-urban interface (WUI)—land near forests and other natural areas where wildland vegetation and development intermix—increased from 1990 to 2010 by 41%. This made the WUI the fastest-growing land-use type in the U.S., a trend that hasn't shown signs of abating since. As the name suggests, some of this land is at the margins of large towns and cities. Much of it has arisen as new residential neighborhoods, but not all of these areas are necessarily under the jurisdiction of nearby municipalities.

To address increased wildfire risk, municipalities have begun to update their jurisdictions by adopting (often amended) versions of several well-known WUI

Ignition-Resistant Eaves (Closed Soffit)



In a big wildfire, strong winds may carry hot embers or even large flaming firebrands for long distances. Embers can be sucked into soffit vents or land in gutters, where accumulated pine needles or leaves may catch fire. The detail at left reduces these risks; the soffit and fascia are noncombustible fiber cement, the roof is concrete tile, and metal flashing laps down into the metal gutter. The rough bottom surface of the tile allows moisture to weep out but restricts the entry of flame and embers.

standards, which include Chapter 7A of California's Building Code (identical to Section R337 of the California Residential Code), the International Code Council's Wildland-Urban Interface Code (IWUIC), and the National Fire Protection Association's NFPA 1142.

All those documents are similar in nature and implement a two-pronged approach to reducing the risk of home ignition: They call for ignition-resistant building details for the house itself, along with the more traditional measures to control natural fire hazards on the landscape surrounding the home.

We know how to do this. These approaches have been around for decades but have only become more widely adopted and publicized as the size and intensity of wildfires have grown in recent years.

RESISTING EMBER STORMS

In most wildfires, windblown embers—which can fly for a mile or more in a high wind—are the biggest danger to homes. These embers may land on a roof or collect in a gutter or valley, setting fire to accumulated leaves or pine needles. Sometimes they pile up at the base of a house wall, then ignite siding or the exposed bottom edge of sheathing. And typically, embers are sucked into soffit or gable-end roof vents, igniting the attic and burning the home from the top down.

To limit embers from setting fire to buildings, codes focus on all the areas where they can collect. (Focusing on these areas is also the strategy for hardening existing homes, which don't always fall under the requirements of building codes.) Often, these corners and crevices on a building exterior are the places where leaves, tree needles, and other organic debris accumulate, creating tinder for the embers to ignite. Places like gutters, roof-wall intersections, and the gap over the ledger for an outdoor deck should be cleaned of debris regularly, and an area 6 inches to either side of such prime collection places should be replaced with noncombustible material. Few WUI codes require gutter guards, but these are a good way to limit the accumulation of debris. Clearly, upkeep, as much as construction, comes into play in protecting homes from wildfire.

Base of walls. Embers piling up against a house can set the exposed bottom edge of wall sheathing on fire, even if the cladding is noncombustible. The gap between cladding and the foundation should be air-sealed with fire-rated caulking (or 1/8-inch wire hardware cloth, if weep holes are needed). Testing by the Insurance Institute for Building and Home Safety (IBHS) on full-scale homes subjected to an ember storm demonstrated that a 6-inch separation between combustible siding and the ground is enough clearance to sharply reduce the risk of fire from embers at the base of walls.

Roof vents have to be screened with wire mesh or hardware cloth, with openings no larger than 1/8 inch. According to wildfire expert Stephen Quarles, who helped craft California's wildfire code before joining IBHS, 1/8 inch is a compromise. While the mesh may let small sparks through, it will hold out the bigger embers that carry the most heat. At the same time, the holes are big enough

Ignition-Resistant Eaves (No Soffit)

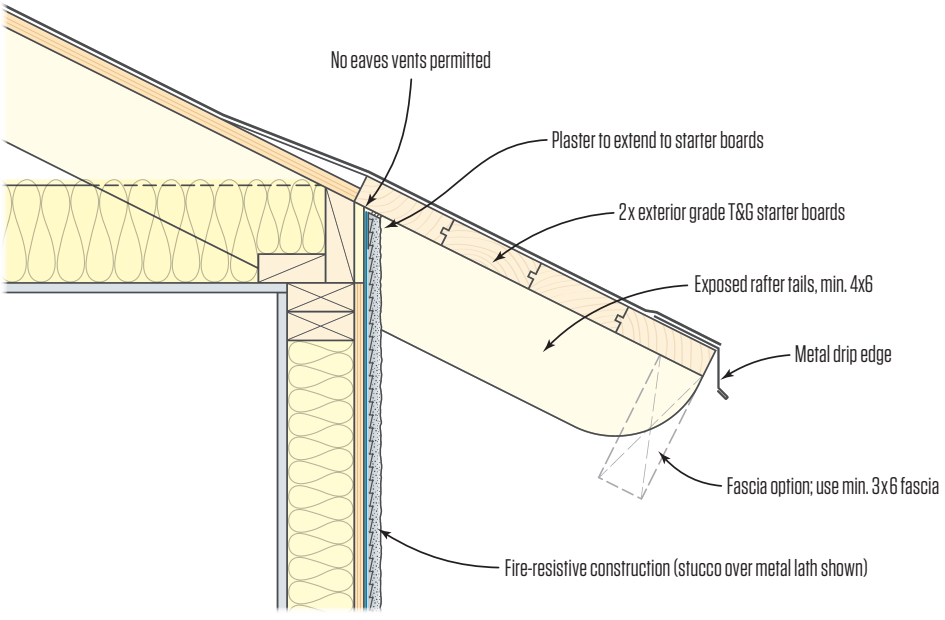


Illustration adapted from San Diego County Department of Planning and Land Use

In open-eaves construction, blown embers can accumulate between blocking and rafter tails and may be sucked directly into the roof assembly through soffit vents in the blocking. For this reason, some Western municipalities have adopted Wildland Urban Interface (WUI) codes that call for unvented roof assemblies and thicker than usual solid-wood rafter tails on the exposed underside of roof eaves. Solid wood is less likely to be ignited by embers and is more likely to char over if does catch fire.

that they're less likely than finer mesh to become plugged with paint or dirt over many years in service.

Eaves and soffits. Soffits and fascia should be built with ignition-resistant material such as fiber cement or metal. Decorative features like false rafter tails on open eaves are allowed to be made of wood, but the fire service strongly urges builders to choose larger members or ignition-resistant options whenever possible.

FULLY HARDENED EXTERIORS

While forest fires can produce a lot of flying embers, a house on fire has the potential to produce far more, and this potential lasts for a longer period of time. As neighborhood density has increased, the most likely ignition path for a large number of homes in the WUI is the house next door. As a result, the focus on fire prevention in more densely developed areas zooms out to address the full building exterior, where intense heat and flames from a building measured in tens or fewer feet away pose a risk *as well as* the embers collecting in the home's cracks and crevices.

Roof areas. Most WUI codes require Class A roof systems. The Class A rating is based on laboratory testing of roof assemblies, in which a large crisscross stack of burning wood is placed on the roof covering and allowed to burn out. The assembly passes if the sheathing is not ignited. Concrete tile, clay tile, slate, fiber cement, and metal roofing typically provide enough protection to pass, as do most Class A–rated fiberglass asphalt shingles.

Bear in mind that because the rating is based on an assembly, code doesn't always require that the roofing be the sole deterrent. Roofing with a lower-class fire rating may still be used (at the discretion of the jurisdiction) if installed on battens or over upgraded underlayments that are deemed sufficient to resist heat transfer.

Doors should be noncombustible. Wood doors with solid cores at least 1 3/4 inches thick qualify. Any glass in the door must be either tempered safety glass or multilayered glazing, with one exception: Front entry doors with decorative single-pane glass are allowed.

Windows must be dual pane. Research has shown that dual-glazed windows can survive the intense radiant heat of a wildfire. (Typically, outer panes crack or collapse, while inner panes survive.)

Tempered glass has proven to be the best performer in practice, as well as in laboratory testing. Wildfire expert Stephen Quarles points out that even before wildfire codes began to take effect, code required tempered glass for certain windows, such as windows close to the floor or next to stairs. Thus, most window companies have had no difficulty making dual-glazed tempered options available.

Deck areas. Brush and trees near a deck can readily catch fire, as can stores of combustible material such as firewood stored under a deck. Windblown embers can also ignite a deck, but composite decking typically proves less likely to ignite than wood decking, which tends to split and crack and catch hot embers. Most WUI codes require ignition-resistant or noncombustible material for decking but allow wood framing for the deck structure.