Retrofit Your Home for Wildfire

Introduction

In 2014, I moved into an aging, wood frame house Santa Paula, Ventura County, in what I now know is referred to as the Wildland Urban Interface (WUI). At first, I believed that "defensible space" was enough. And then… the Thomas Fire. After that, my insurance company no longer writes new policies in the 93060 ZIP code.

I spent the first 11 days of the fire watching the flames burn towards Fillmore and reading a firefighting textbook, the only thing I could concentrate on. The section of Essentials of Firefighting that interested me most, discussed building construction. I was interested to learn that my house is considered "Type V," which I interpret to mean "the fifth best kind, out of five construction types. A wood frame house is probably a good thing in an earthquake, less so in a fire, especially when the lumber used is synthetic like particle board. Adhesives that hold those particles together are often extremely flammable.

This article is the direct result of my research. I was working on my own retrofit while I researched and wrote this article. Most of the material, including the majority of the illustrations, come directly from their online PDFs. Their "Home Builder's Guide to Construction in Wildfire Zones" has very useful guidance on both new and existing buildings. It's easy to find if you google something like "FEMA wildfire fact sheet windows" or "FEMA guidelines exterior walls fire."
The information is neatly divided up by category into fact sheets, so you can look for "decks" or "roofs" individually if you are not interested in reading the entire manual. I found these guidelines to be the best and most complete source of information on this topic.

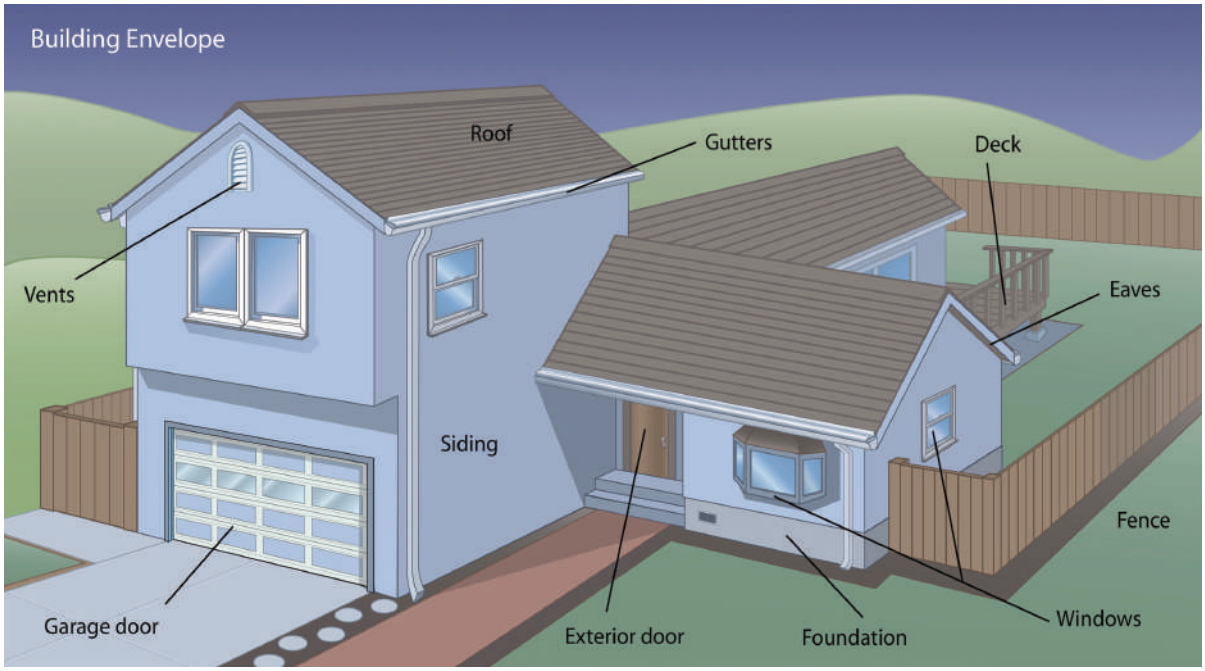
Good luck to my Altadena neighbors as they struggle to rebuild.

The Thomas Fire, December 4th, 2017 from South Mountain Road looking towards Santa Paula. (Naomi Pitcairn)

The Building Envelope

Structures need to be sealed up tight. FEMA's guidelines on construction start with the concept of the "Building Envelope" which is made up of the doors, windows, walls, whatever separates the interior of a home from the exterior. Your home's entire envelope needs to be sealed up or hot gases and embers can get in wherever you leave openings large enough. You need to assess all of the envelope's weaknesses, anything that is built from flammable materials and any holes bigger than ~1/16-inch, especially if they face the East/West winds.

"Unless construction measures that provide protection from a wildfire are implemented, heat and embers can penetrate the building envelope at vents, unsealed mechanical or electrical openings, and through windows broken by heat or wind-blown firebrands. When these openings are penetrated, the building can burn from the inside out. If the envelope has been designed and constructed to be fire-resistant, both the exterior and interior of the building will be more capable of resisting a wildfire long enough for the danger to pass or for firefighters to arrive." - FEMA



The building envelope separates the interior from the exterior of a structure. (FEMA)

Put simply, ANY hole in the building envelope is a vulnerability. Vents, cat doors, windows, cracks and holes in the wall, foundation or roof. We are all familiar with embers, those little spark-like things that dance above any campfire. Embers are different from flames, like the pilot flames on gas flares. They are little pieces of burning fuel. When dry wind and parched vegetation come into the picture, they carry just enough fuel to allow them to burn long enough to ignite spot fires, on anything from dry leaves to your doormat. When they can't get in anywhere, your structure is less likely to burn.

When embers are excluded, from your building you have one less thing to worry about and you cans start thinking about the flammability of your construction materials, the proximity of fuels to your structure, and the flammability of the contents of your home. Fire officials don't want you to stack wood against your house. This is why I'd move my old, wooden tool shed, and why I'd maintain any outbuildings on my land as carefully as I'd maintain my primary structure.

Roofing

There are two kinds of roofs, steep-slope roofs and low-slope roofs.

Steep-slope Roofs: Steep-slope roofs like the one on my house are at risk of embers being blown under their roof coverings, even if those coverings are fire resistant. Because of this, it's really important to install an enhanced, fire resistant underlayment like a mineral-surfaced cap sheet that's rated for a Class A rated assembly.

FEMA recommends normal, not lightweight clay or concrete tiles for steep-slopes because of their greater mass. If the tiles are installed over wood battens though, embers may still be blown under the tiles and ignite the battens. FEMA recommends using fire-retardant treated battens and putting birdstops at the eaves.

Low-slope Roofs: There are a variety of Class A rated coverings for low-slope roofs. FEMA is very clear that Polyisocyanurate roof insulation should be installed. According to one of numerous manufacturers, it has a "high level of inherent fire resistance when compared to other foam plastic insulations due to its unique structure of strong isocyanurate

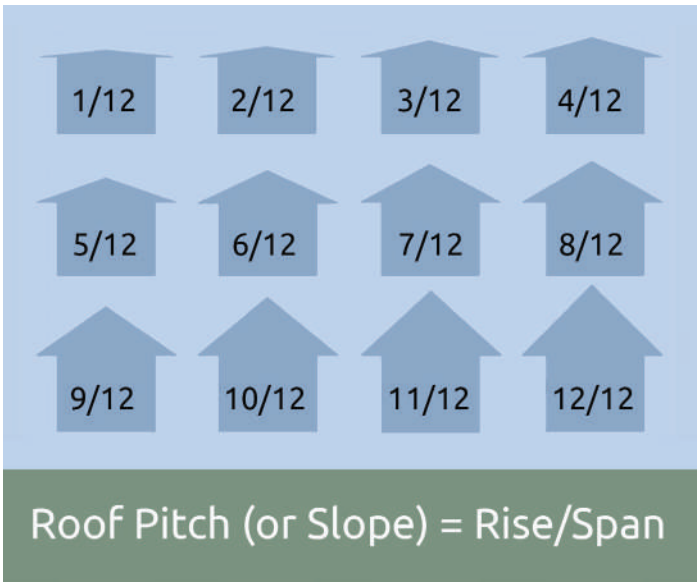
"The most common cause of a house burning in a wildfire is having a wood roof."
(Richard Halsey, SDSU)

"The probability that a home will survive a wildfire is greatly influenced by the components of the roof assembly. The type and arrangement of the components govern their potential for ignition and their propensity to transfer heat into the interior of the building." (FEMA)

Because roofs are complex and vulnerable to fire, they deserve serious, thoughtful consideration. Your roof is key to your home surviving wildfire. A flammable roof will burn, as will anything flammable, like leaves that's on the roof. If you have an attic, visit it and look for flammable materials and/or entry points for embers.

There is a range of protection within the Class A rating. Some Class A assemblies have noncombustible roof coverings (such as clay or concrete tiles and metal panels), while others have combustible coverings (such as asphalt shingles and low-slope membranes). A structure in the WUI should not be made from combustible materials, period.

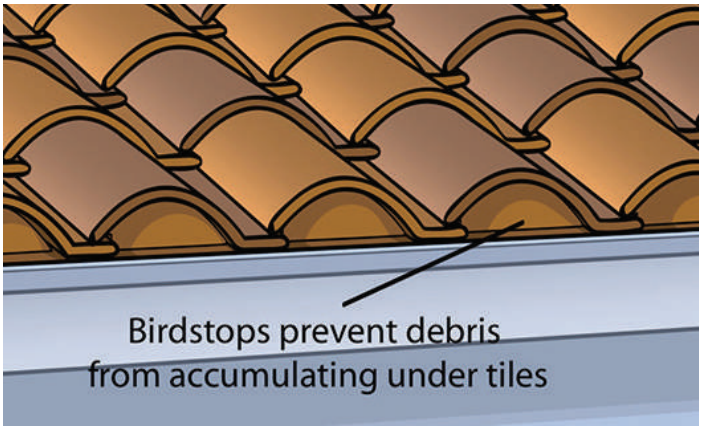
A standing seam metal roof is a good choice for the WUI and as a bonus, solar panels will attach easily to the raised seams. (Navarro Roofing)



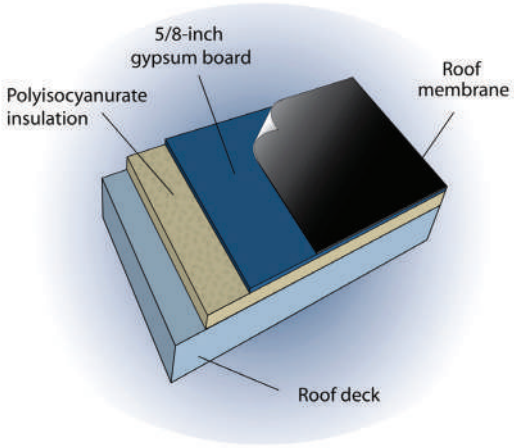
A low-slope roof pitch has a ration of less than 3:12. (Adapted from web image Naomi Pitcairn)

Roofing Cont.

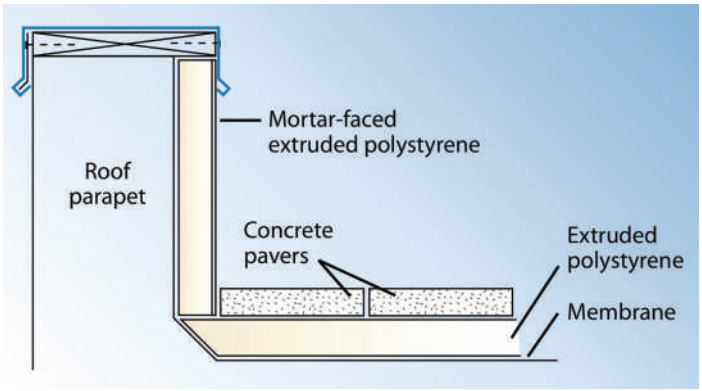
Displaced tiles, no matter how good, will allow ember entry. (FEMA)



Birdstops close up the holes under curved tiles. (FEMA)



Components of a well put together low-slope roof. (FEMA)



Concrete pavers over a roof membrane. (FEMA)

If you're thinking of going with metal shingles or panels, know that although they are non-combustible, they will transfer heat. If they are installed over wood battens, those wood battens should be fire-retardant-treated. If you use wood decking, you should install 5/8" gypsum roof board (complying with ASTM C 1177,Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing) immediately below the membrane. Glass mat gypsum gets its tensile strength from fiberglass fibers rather than carbon based fibers.

You can have a Class A rated wood roof if the shingles or shakes are fire-retardant treated and a specific cap sheet underlayment is installed. Looking at the roof while taking the building envelope into consideration, it's quite possible that many of the fixes are relatively inexpensive.

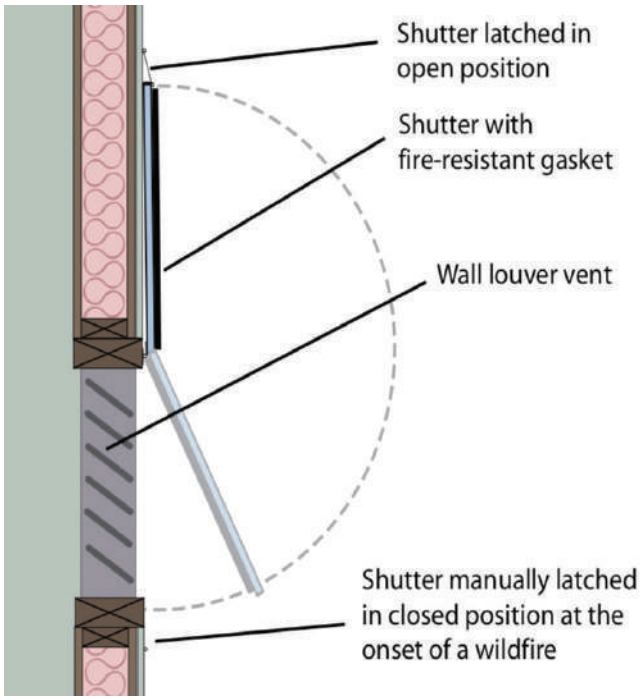
Trade-offs: Since I can't bear to cut down the trees that shade my house, I've decided to practice what I call "fire hygiene." I'm up on the roof with my blower every week when I clean house. It's part of the ritual now. Of course after that I also have to rake up all the leaves I blew off. When I'm tired of doing all that, maybe I'll cut down my beautiful tree that keeps the sun off my house. It's puzzling that sometimes a tree is what causes a fire and at other times, trees appear to stop fires. I imagine that the moisture content of the tree is a major factor. My tree-positive strategy is to give my trees the water that the bushes I removed would have gotten. This way I have no fire ladder to my trees and wetter trees. That said, I've made a choice. Leaf litter on your roof is a big no-no according to all the fire experts.

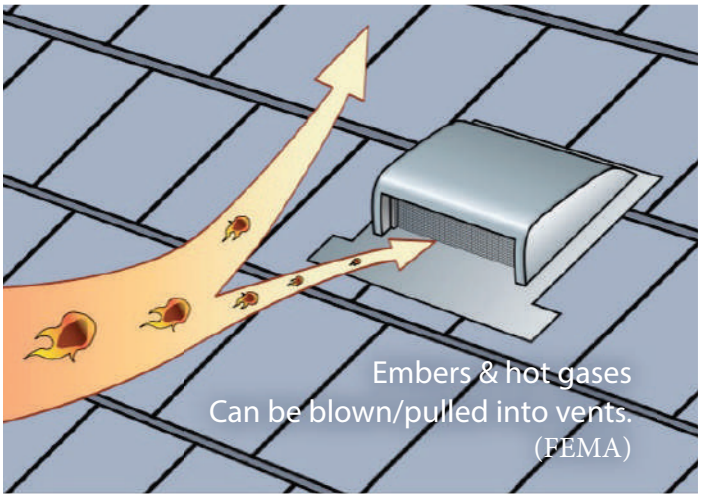
Vents

The vents that circulate fresh air and keep mold at bay, are also holes in your building envelope. Vents are one of the main entry points of fire. The wind can blow embers right into your house through your vents unless they are protected by a fine enough, screen mesh that won't melt. The good news is that fixing your vents is relatively inexpensive. Replacing existing vents with Vulcan™ vents is an interesting alternative. Vulcan™ vents have honeycomb mesh core that will seal at 350° Fahrenheit. I chose those, although FEMA doesn't mention them. I prefer things that will happen automatically without me having to be there.

HVAC systems, including exhaust fans, should be TURNED OFF when a wildfire threatens. Attic exhaust fans should also be shut down.

Vent Maintenance: The homeowner should periodically remove debris that has accumulated near or on vent openings, vent screens, and louver blades. The amount of vegetation near vent openings should be limited.





Foundations & Exterior Sprinklers

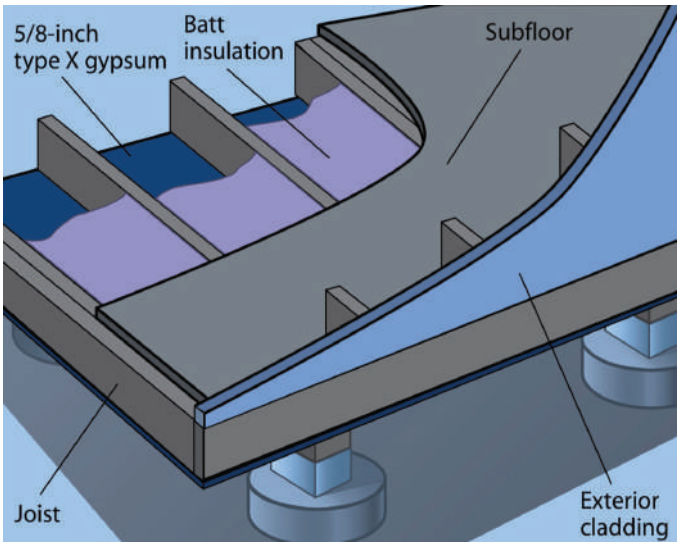
Foundations and siding can let embers in if not properly sealed. Vents are not the only point of entry for embers. They can enter gaps between wood siding boards and through holes in old rock and rubble foundations. There are many reasons to retrofit an old foundation for earthquakes as well as fire. You can add a layer of insulation underneath the joists of your floor, or install a sub-floor of gypsum board or similar products such as DensDeck™ if you are looking to improve your odds. Don't forget that your house can burn down no matter what you do. There is no such thing as a "fireproof" structure.

I chose to replace the rock with a poured foundation. You can also add a layer of insulation underneath the joists of your floor, or install a sub-floor of gypsum board or similar products such as DensDeck™. It just depends how fanatical you want to get. Don't forget that your house can burn down no matter what you do. There is no such thing as a "fireproof" structure.

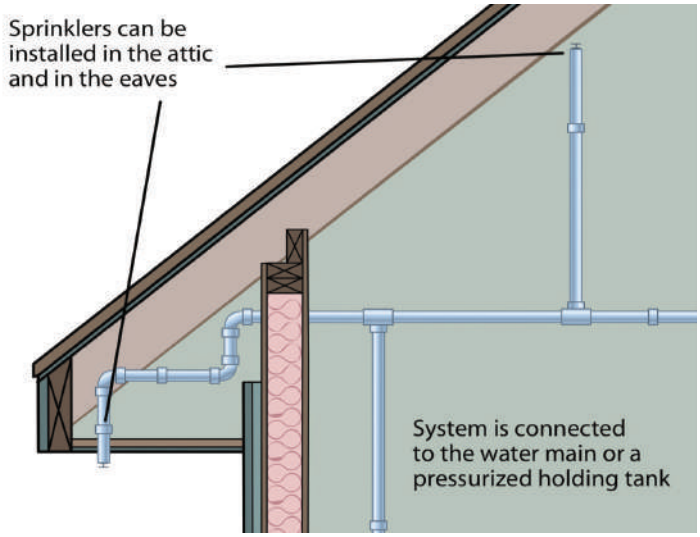
"Exterior sprinklers mounted on the building can be configured to use water piping through the attic or roof or to use piping on the exterior of the structure. If interior pipes are used, exterior sprinklers can be installed in conjunction with interior sprinklers. A stand-alone system that includes a pressurized holding tank can be considered to ensure an adequate water supply." (FEMA)

Exterior fire sprinklers are designed to saturate the exterior of a building. They can be installed in new or older buildings. The sprinklers can be set to be activated automatically by low-voltage heat detectors and can even include a warning system that notifies occupants and emergency personnel of a developing fire. Note that the sprinkler heads in the illustration below are at the soffits and on the roof, two of the most likely places for a fire to take hold.

Landscape sprinklers can be designed and installed to provide protection to landscape areas immediately surrounding buildings.



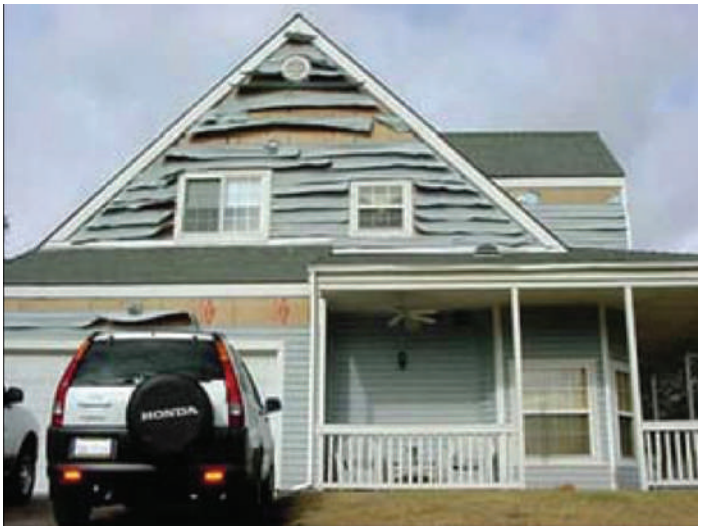
5/8-inch type X gypsum board attached to the underside of the joists, example of a fire-resistant sub-floor/underlayment. (FEMA)



Interior and exterior fire sprinklers can be installed in conjunction with each other, such as this system with a sprinkler in the attic and along the eave. (FEMA)

Siding & Wall Assemblies

Anything plastic is probably going to melt in really high temperatures, including siding, frames and those cozy, furry blankets on your bed. When I saw the below picture of the melted vinyl siding I choose fiber-cement boards because it's hard to replace windows in stucco homes although stucco is much cheaper than fiber-cement.



Burned vinyl siding. (FireCenter.berkeley.edu)

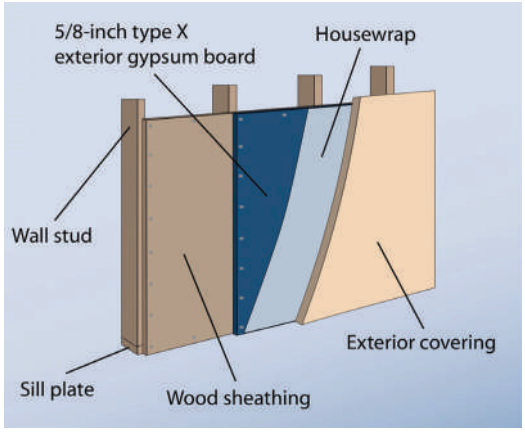
FEMA's guidance on fire-retrofitting of exterior walls is to replace exterior wall coverings that are combustible, are susceptible to melting, or can readily transmit heat with fire rated assemblies. Examples of the types of coverings that need to be replaced are: wood siding that is not specially treated to be fire-retardant, vinyl siding, metal siding, and an exterior insulation finish system.

Before replacing vinyl or metal siding, check whether there is an underlying gypsum board substrate. If so, remedial work may not be needed. Determine whether keeping the existing covering and covering it with 5/8-inch type X gypsum board and a new covering is a viable option.

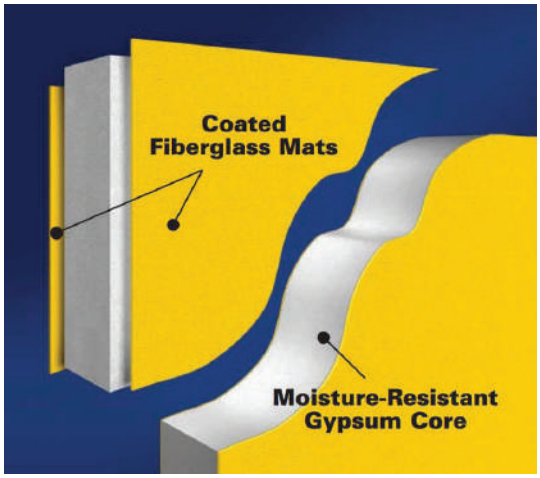
Waferboard, and even many plywoods, are not ideal for wall sheathing in the WUI because the glues that hold them together are flammable. For my wall assembly, I chose mineral wool insulation for its ability to hold its shape,
The more you fill space, the less the fire can grow. I chose DensGlass™ wall sheathing which is a type of gypsum board that uses fiberglass fibers instead of the natural fibers normally found in gypsum board, making it more water resistant than traditional gypsum board as well.

Fire experts frequently recommend mineral wool as an alternative to fiber glass or other insulation for its ability to maintain its shape. The less space your insulation gives the fire, the better. Mineral Wool is also good sound insulation. DensGlass is an alternative to gypsum board for wall sheathing. Several brands of fire-resistant, treated plywood exist as well but are is very expensive. Interior walls should have two layers of drywall.

One brand of mineral wool (manufacturer)



A fire rated wall assembly (FEMA)

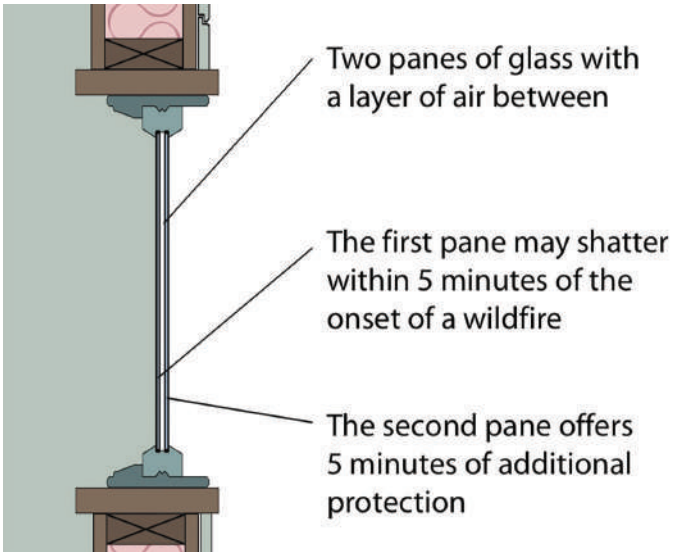


DensGlass™ structure (Georgia Pacific)

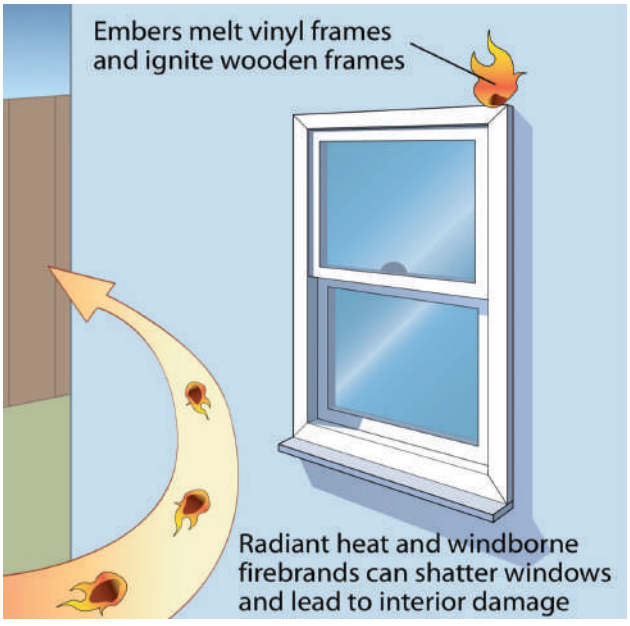
Windows & Skylights

If you have an old house with mostly un-tempered, single pane glass with wood frames you should replace them with windows that are dual-pane, tempered glass and have a metal, or metal covered wood frame.

This particular FEMA recommendation caused me some aggravation at a window showroom I shall not name. The aggravation came about when the salesman told me that if I had metal frames, I wouldn't pass Ventura County residential window replacement specification, which requires a U-factor of .32 or less and SHGC of .25 or less. In brief, he told me that the metal frames would conduct too much heat into or out of my home to be energy efficient. At Avalon Door & Window, Karen Ronchetti cleared everything up. She told me that there is such a thing as a "thermally broken" window.



Double-paned glazing
(FEMA)



Window framing is a vulnerable point of building envelope.
(FEMA)

A wooden window frame in flames
(firecenter.berkeley.edu)

U-Value is the measure of a window's ability to reduce heat loss during indirect radiation exposure; such as during the winter months in moderating climates. Lower U-values translate into less indirect heat lost from the interior of the home resulting in lower heating costs.

Solar Heat Gain Coefficient (SHGC) is a measure of a window's ability to reduce heat gain during direct radiation exposure; such as during the summer months in warmer climates. A lower SHGC translates into less direct heat being pulled into the home resulting in lower cooling costs. SHGC and U-value are closely linked since the lowering of one directly affects the other." (Hub Pages)

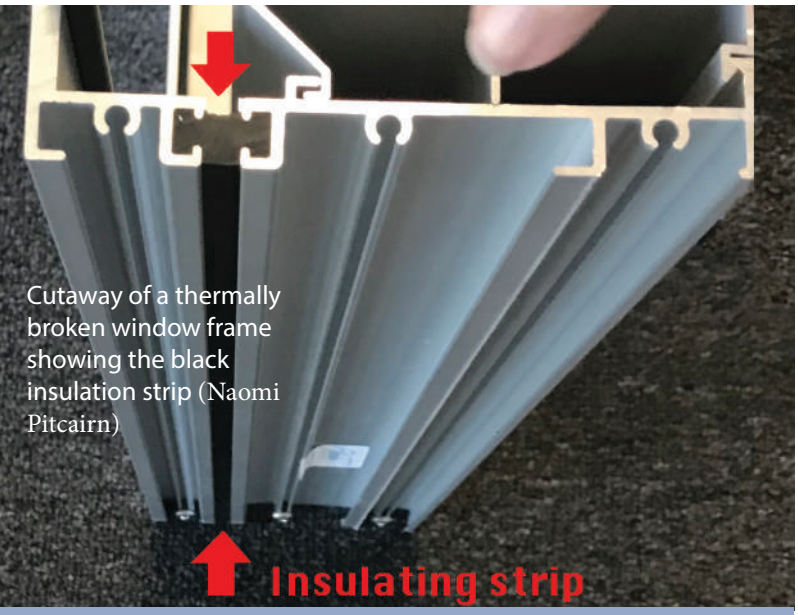
Windows & Shutters

Avalon has a section of a thermally broken window frame on display at their Ventura location. It had been cross-sectioned so that you could see the internal structure. As you can see in the picture below, a dense, rubber strip separates two separate, metal frames and holds them together. The rubber acts as insulation between the two metal pieces. Another window option that provides both insulation and heat resistance would be metal-clad wood frames. Sometimes these are less expensive.

Fire retardant curtains can also been known to be helpful. They tend to be heavy. On the other hand, flammable curtains can catch fire just from the exterior heat. It is probably advisable to store flammable items away from windows. If you are evacuating, try not to leave things like ammunition, hair mousse and gasoline.

FEMA recommends metal shutters, but in order for them to work properly, they need to be installed correctly and FEMA has guidance on that too.

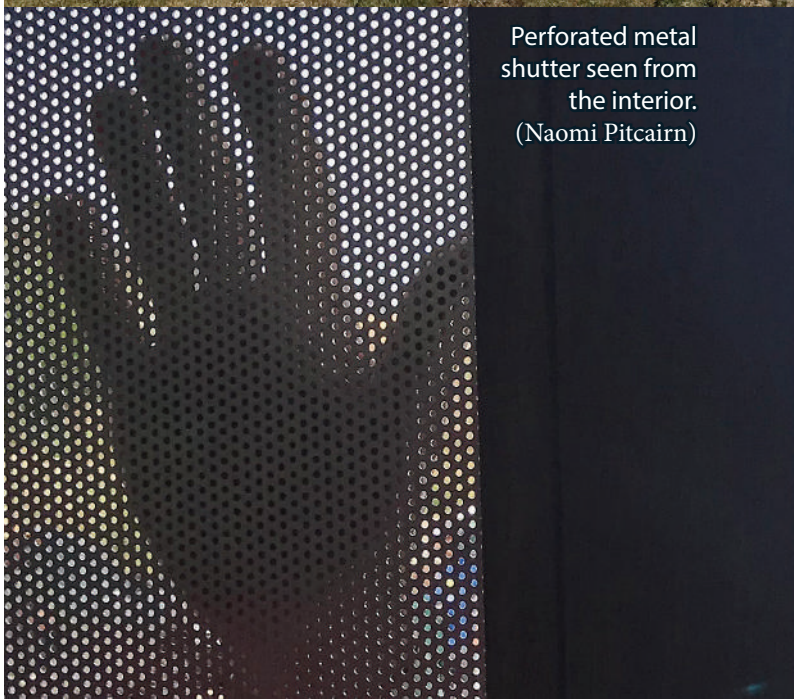
Below are photos of a home designed by John Davis and Lorrie Brown of DB:A architecture, in Ojai. The Thomas Fire passed directly over it, but the interior did not get above 150° Fahrenheit in spite of the 1000° outside. The house has a concrete slab floor, no crawlspace, and a steel structure. It does not use plywood anywhere. Instead, they used shear panel Sure-Board backed with steel sheeting. The framing of the perforated steel, barn doors that protect the recessed windows is of ipe wood, which is very fire resistant. The house has no attic and minimal eaves. As an aesthetic note, the perforated metal shutters not only protect the recessed windows but also add privacy while you can still see out from the interior.



Cutaway of a thermally broken window frame showing the black insulation strip (Naomi Pitcairn)

Cutaway of a Wood-clad frame (Manufacturer)

Two types of metal shutters on a home designed by DB:A (Naomi Pitcairn)



Perforated metal shutter seen from the interior. (Naomi Pitcairn)

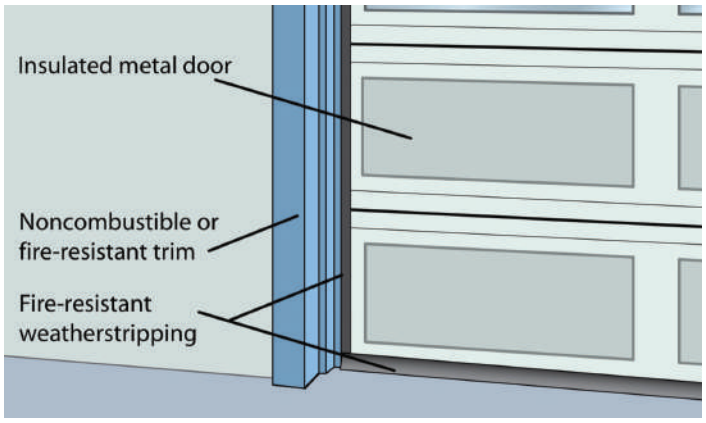
Exterior Doors

Exterior doors have some of the same issues as windows do. The main issues with exterior doors are the fact that they are usually thinner than a structure's exterior walls and so, burn through faster. Your door should have at least 3/4 the fire rating of your exterior wall. A solid door is generally more fire-resistant than a hollow one. If doors are made from combustible materials, they can catch fire. Flames and hot gases can penetrate openings between the door and frame and under the threshold. Embers can get lodged in those same openings or blow through them, into the interior. This makes weather stripping important. Flames and radiant heat or firebrands can break the door glass.

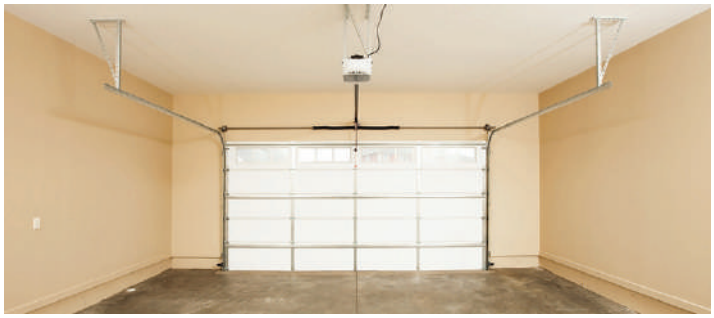
For door glass, you follow the same guidelines as for windows and skylights: double-paned, tempered glass. FEMA also recommends "adjustable weather-stripping on the interior side of the door frame" and an "automatic door bottom or threshold weather-stripping."

Types of exposure an exterior door can face in a wildfire. (FEMA)

Garage doors should be insulated, made from or covered in metal, and have weather-stripping that meets UL Standard 10C around the entire garage door. In an extreme risk area, it might be worth it to spend the money on an industrial grade roll-down fire door.



Garage door with fire-resistant components. (FEMA)



A fire resistant garage door from AAA Door Guys in Ontario.

An industrial fire resistant garage door (Manufacturer, Bayou Doors)

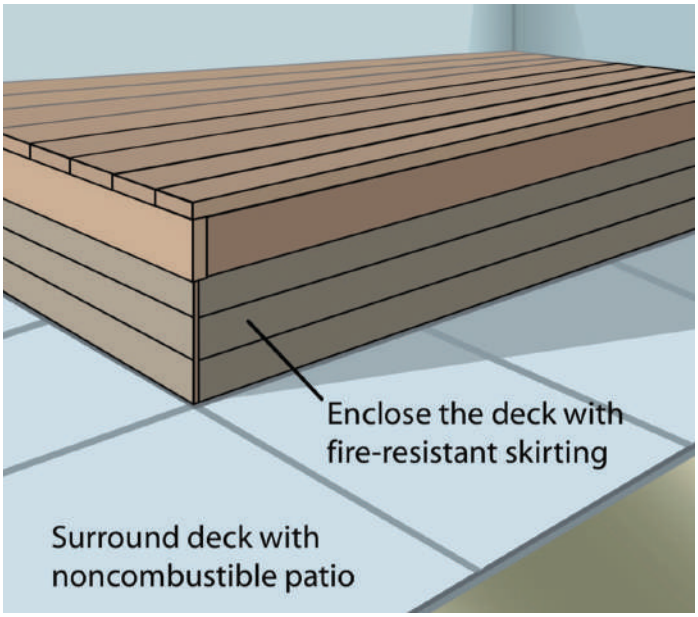
Decks

Heat rises, so it accumulates under overhangs. Imagine heat being pushed long and hard against your house by dry, Santa Ana winds. As it rises, it will get stuck under any type of overhangs the winds push even more heat against the exterior walls.

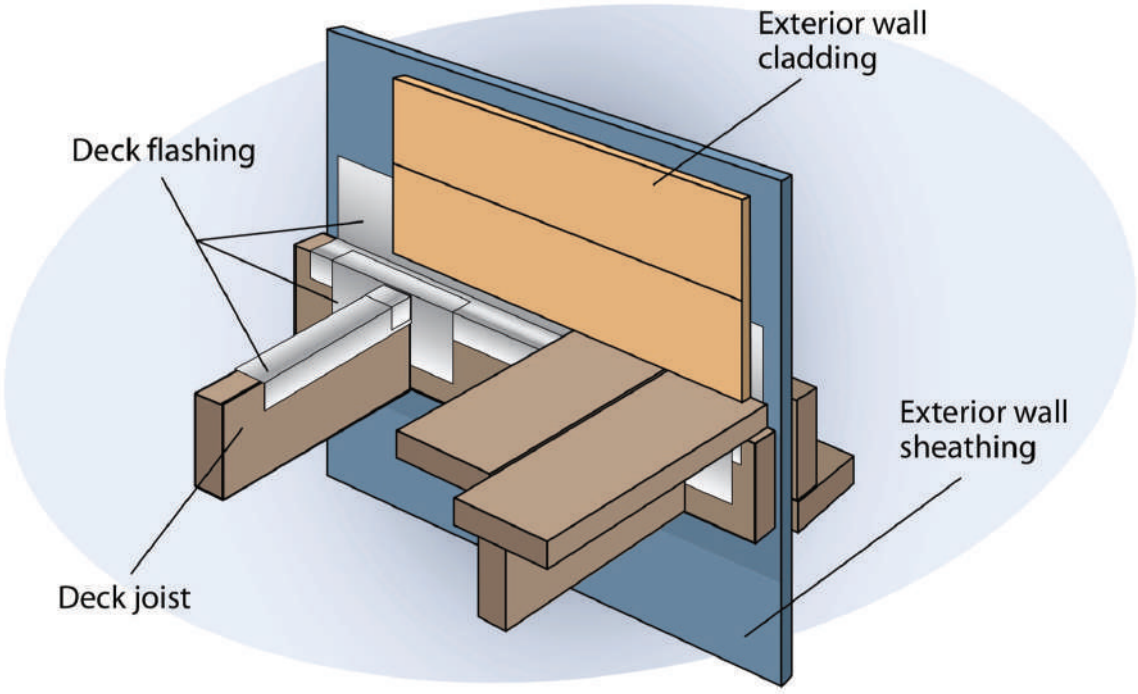
This situation makes any kind of overhang, be it a deck, soffits or something else is a point of vulnerability to your structure. There are illustrations of this principle on the following page shared from Chaparral and Fire Expert, Richard Halsey's book: "Fire, Chaparral, and Survival in Southern California."

There are porcelain tile options that are very attractive and durable. The link here is to a one brand. I haven't tried it. Glass railings are an alternative to ones made of wood.

Attaching the deck to the home correctly is complicated but important.

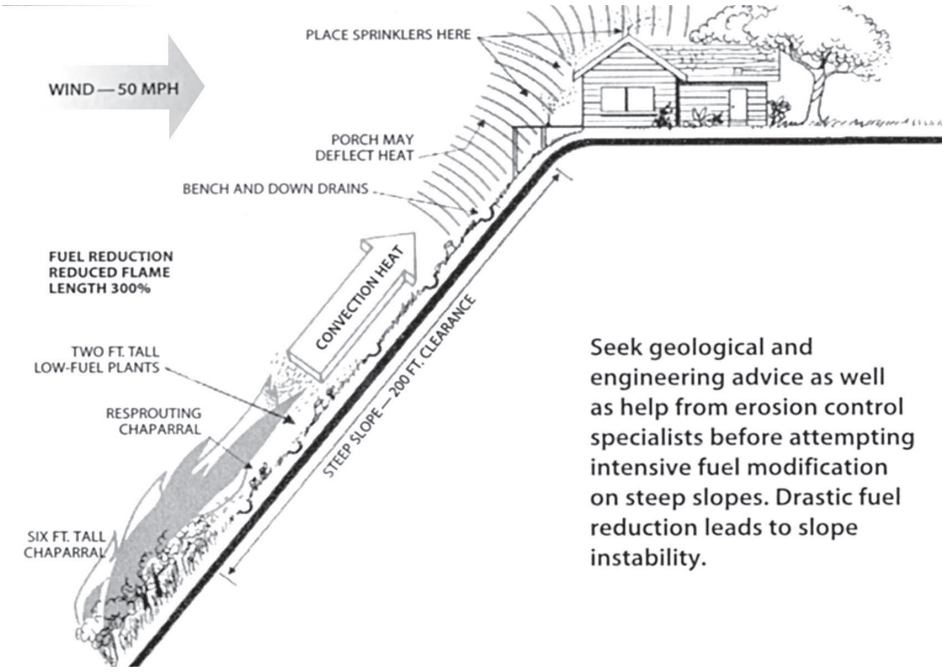


An example of a well done patio retrofit. (FEMA)

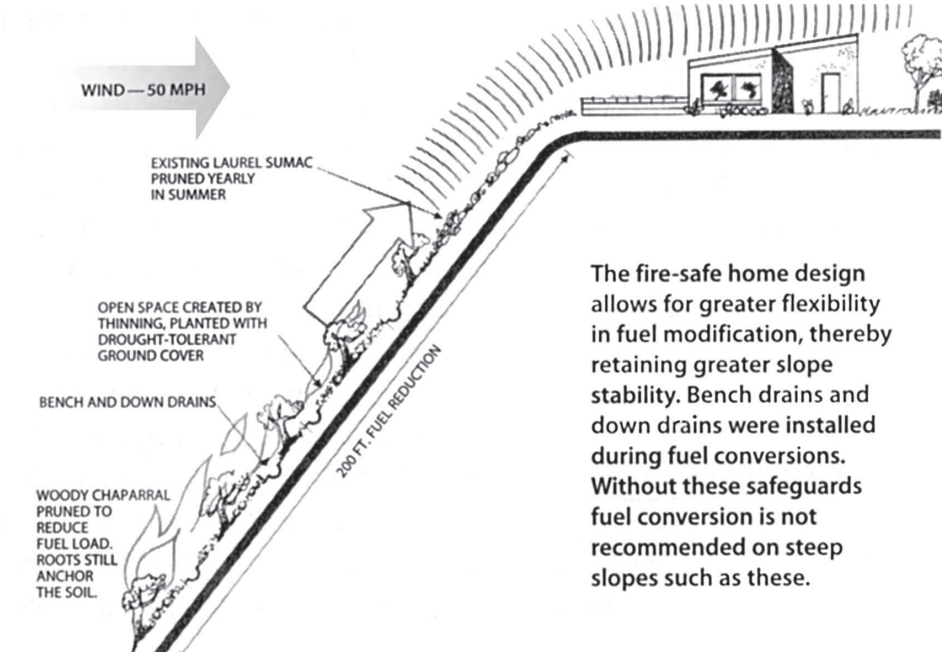


The connection between the deck and house needs special handling. The above illustration details some of FEMA's suggestions and there is more on their site. (FEMA)

Setback from Slopes



Heat, especially when blown by wind, can get caught under decks and eaves. This is an example of a less than ideal setback.

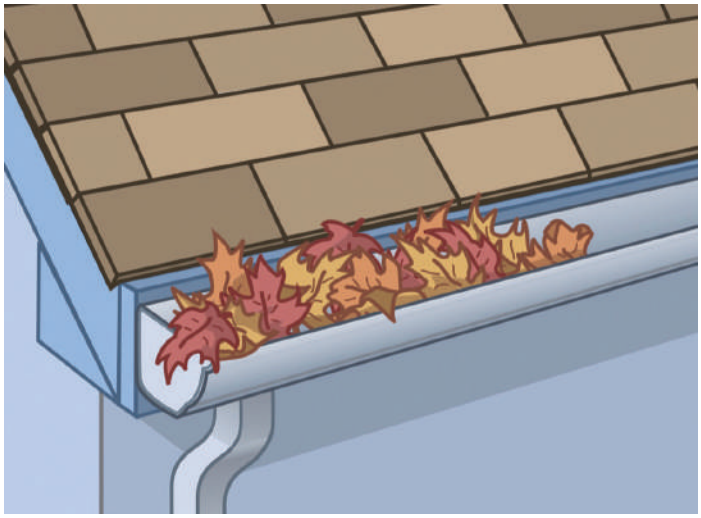


The deck and house set back from incline and angled to deflect heat.

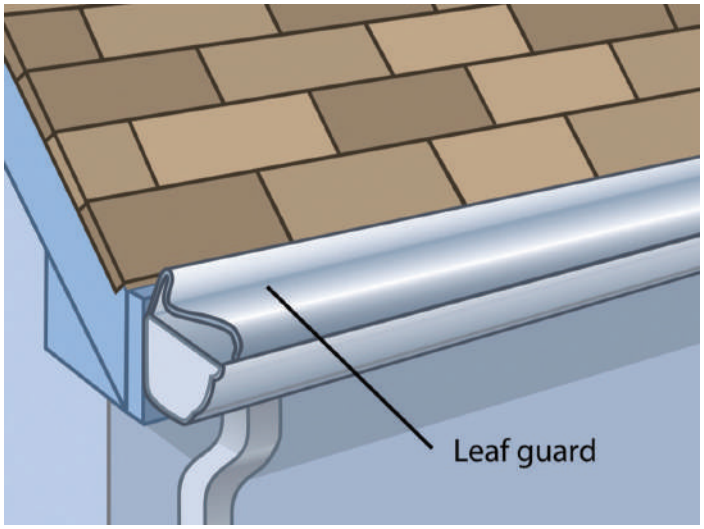
Illustrations adapted from Fire Chaparral, and Survival in Southern California,
(Used with the author's permission)

Gutters & Soffits

Gutters and downspouts should be made of non-combustible materials. Leaves that accumulate in gutters are a fire hazard. FEMA recommends metal-hood leaf guards. I tried the mesh screen ones but it just made it harder to clean out all the little ash seeds that got stuck in them so I took them out. The metal hood leaf guards look like they might have similar problems. I've opted to remove my leaf guards and blow the roof off instead. If I get tired of it I guess I'll cut my tree down or trim it.



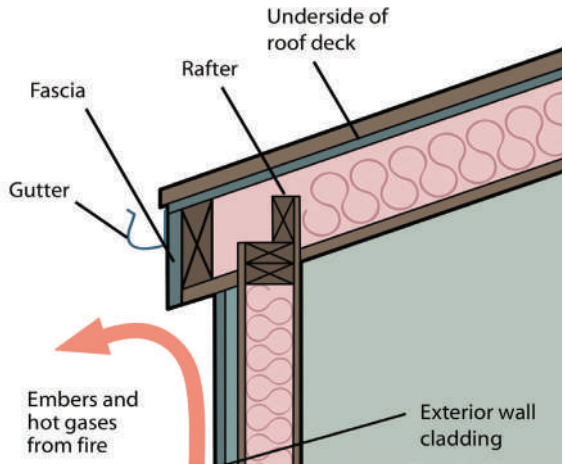
Trapped leaves can be excluded using a leaf guard. (FEMA)



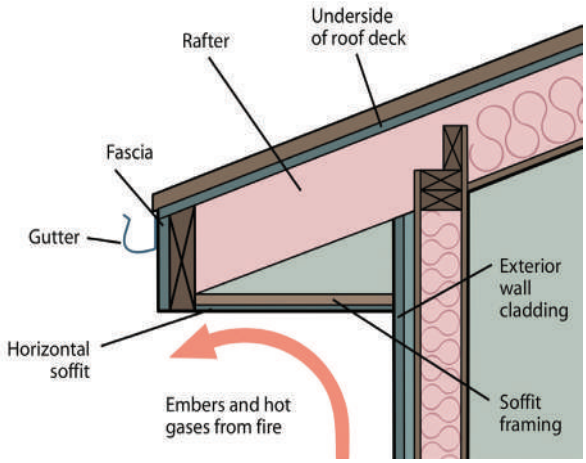
Gutter with leaf guard installed (FEMA)

A flat soffit reduces the potential for entrapment of embers and hot gases. FEMA recommends cladding that flat surface with a fire resistant material like treated lumber or fiber-cement board.

Trapped heat and gases could enter through the vent holes in these exposed eaves. (FEMA)



An eave with essentially no overhang



An enclosed overhang with horizontal soffit (FEMA)

Sleepless in the 805 (Naomi Pitcairn)

The sad truth is that you could do all of this exactly right and your house could burn down anyway so don't feel too bad if you don't meet the FEMA standards. I put some stuff in storage at the other end of town. I have copies of all my important documents on a flash drive in my "go bag." I'm backing up my hard drives regularly and storing them. My fancy clothes, what I have of them, will go in storage as well. All I will need to grab when I run, is the go bag with my essentials and my cats. Good luck to us all as we try to improve the safety of our homes, one item at a time. Leave your wooden fence gates open to create a fire break.

UPDATE: I did everything to my 100+ year old house. I installed Vulcan vents, put on a metal roof, replaced my ancient windows with thermally broken double-paned ones. I redid the wall assembly using mineral wool insulation because it doesn't slump and leave space for the fire. I coverd that with DenseGlass gypsum board and the outer layer is Hardee board. I replaced the patio cover with Alumawood. We put a blowtorch to it. It didn't burn. I covered the deck with porcelin pavers that were easy to install, The deck reailing is tempered glass and steel. My next door neighbor's home tragically burned to the ground in the Mountain fire.

MINE DID NOT.
Naomi Pitcairn 2025