A Homeowner's Guide to Fire-Resistant Home Construction

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INTRODUCTION

In the wake of hurricane Katrina, the American people should now realize that federal, state, and local governments cannot always come to the immediate aid and rescue of people suffering in the aftermath of a natural disaster. This reality especially applies to rural residents living in the Wildland/Urban Intermix (WUI) Zone where homes and communities are located adjacent to flammable wildland vegetation. There is no guarantee that firefighters will be available or able to protect individual homes and properties from wildfires that can simultaneously threaten hundreds of homes. This is especially true when suppression resources are scarce or weather conditions are extreme—which may become more frequent given the growing budget deficit and ongoing climate change.

Field of Dreams: rural residents should not assume that wildland firefighters will always be available or able to defend individual homes from wildfires.

Defending homes from fast-spreading high-intensity wildfires is one of the most difficult and dangerous duties for wildland firefighters. **Firefighters United for Safety, Ethics, and Ecology (FUSEE)** feels strongly that informing homeowners about fire-resistant construction materials will help wildland firefighters better protect communities, and reduce some of the risks to firefighter safety. Moreover, when rural homes and communities are better prepared for wildland fire, then more options and opportunities open up to properly manage fires to restore forests and grasslands degraded from past fire exclusion.

THE PROBLEM

The western U.S. is experiencing rapid population growth and housing development. Much of the housing being constructed is located at the edges of urban areas where houses meet native vegetation, an area called the Wildland/ Urban Interface (WUI) Zone. New homes are being built in relatively dry, low-elevation foothills and canyons amidst highly flammable vegetation that, before systematic fire suppression and fire exclusion, burned fairly frequently. In these WUI areas, fire ignition risk and fuel hazards are now extremely high. While policymakers in Congress and the Administration tend to focus on preventing wildland fires in National Forests, the wildfires in 2006 in Texas, Oklahoma, and southern California demonstrate that homes located in desert, grassland, and shrubland ecosystems are also highly vulnerable.

In California, for example, over 11,055 homes were burned by wildfires between 1990 and 2003. The 2003 Cedar Fire in southern California alone destroyed 4,800 structures and killed 26 people. Nationally, the rate of home losses seems to be increasing, but the problem is not that there are more wildfires burning; rather, more homes are being built in fire-prone areas. In fact, from 1990 to 2000, over 8 million new homes were built nationwide in the WUI Zone, a 22% increase over homes existing in the 1980s. Currently, nearly 40% of all homes are located in the

WUI Zone, equating to almost 50 million homes at risk of damage or destruction from wildland fire.
The scale of the problem seems daunting, and government agencies spend huge amounts of tax dollars, public resources, and labor power to protect homes from wildfires. Providing "structure protection" is one of the most difficult and dangerous assignments for wildland firefighters, and there is no guarantee that firefighters will be available to protect individual homes. Consequently, despite all the money and all the hard work, wildfires burn homes all too often—mostly because many homes are just not designed to survive in a fire-prone wildland environment. We will continue to see escalating costs and occasional tragedy unless we can change the way homes are designed and built.

A SOLUTION

Since it is impossible for firefighters to protect all houses, homeowners must do all they can to protect their own property, and take full responsibility for their own fire safety. Fortunately, at the level of the individual homeowner or rural resident, much can be done to effectively and inexpensively protect one's home and property. New houses can be built and existing homes can be renovated with fire-resistant materials that are designed for a fire-prone environment. While no built structure can escape fire damage under all conditions, good design and construction materials can greatly increase the survivability of a home.

DETERMINING HOME IGNITABILITY

Recent research and common sense advice from firefighters point the way to safer homes in areas where wildland fire periodically burns. We can build fire-adapted housing if we understand how fire gains access to buildings.

Wildfires gain access to homes in two main ways:

1) A flaming front burns close enough to the home so that the heat ignites the structure.

2) A flaming front throws embers and firebrands into the air and these "brands" ignite the structure.

In laboratory settings, a reasonable set of proxies for testing these methods of flame entry has been developed. First, a torch similar to a propane torch in your garage is applied to a test structure. It is applied at a given intensity for a specified length of time. If the structure doesn't fail (that is, the test structure does not allow flame to penetrate the material) then it "passes."

Frontline Home Safety: rural homeowners live on the frontlines of wildfire events. Building fire-resistant homes and managing vegetation allows homes to survive severe wildfires burning under extreme conditions.

The second method is to construct a standard size lattice of small pieces of lumber, ignite this "brand" and place it on a test roof or deck structure. If the structure doesn't allow flame to penetrate the house then it "passes." For example, to get the rating "Class A" roof materials, the test is to put a burning brand, (a threelayer 12 inch by 12 inch structure made of 3/4 inch diameter sticks) on the roof for 90 minutes. If flames penetrate the roof, it is not a "class A" roof. Susceptibility of a structure depends on both the fuels adjacent to the house and the flammability of the house materials.

MANAGING THE FUELS ADJACENT TO HOUSES

There are many organizations offering tips on managing vegetation to reduce fuel hazards (see links at end of this paper), so a brief summary of the information is provided here. Generally, residents are advised to remove all flammable vegetation within 30 feet of structures. For at least 100 feet from structures, vegetation needs to be modified and periodically maintained. Briefly, the principles to follow in the area within 100 feet radius of a house include:

Reduce small-diameter surface fuels. The surface material that is less than three inches in diameter (the 0 to 3 inch fuels) is what flames spread through. Mow it, rake it, chip it, pile and burn it, but reduce its amount however possible.

Increase tree canopy base height. In forested areas, the distance between the surface fuels (see above) and the aerial fuels (vegetation like tree branches that are suspended above the ground surface) is critical. The greater the distance between these two fuel components, the less chance there is for a fire to reach the tree crown. Crownfires can kill entire stands of trees, and are almost always unstoppable. So if you live in a forested place, prune lower and especially dead branches, cut a few of the small scraggly understory trees, and get some separation between the tree crowns and the surface fuels.

Reduce tree crown bulk density. In densely forested areas and in brushlands, much of the fuel available to burn is the finely divided leaves and twigs in the crown of the plant. So selectively thin out trees in order to stop the spread of fire from crown to crown. This has another long-term benefit: well-spaced trees are less susceptible to bark beetles and other ailments. In brush, you may want to consider cutting corridors through brushfields, rather than thinning, especially if your local brush species are vulnerable to snowdown or snowbreak.

Leave the big trees. Generally, leave the largest individual trees of the most fire-resistant species. With crowns high above the ground and thick trunks that are often clad in thick bark, these trees may actually slow the spread and reduce the intensity of a flaming front as it approaches your house. In the long-term, these large trees give your property "fire permeability" or the ability of fire to safely pass through an area without damaging structures or killing the dominant trees. If you do have a wildfire, the big trees can actually shield your home from some of the radiant heat from the wildfire, and are the ones most likely to survive the flames' passage. They will shade your home from solar radiation and keep the brush down while the forest around your home regenerates. So leave the biggest trees standing.

Modify the manmade fuels adjacent to the house. Decks, fences and other flammable manmade constructions need to be designed or located so they do not "wick" fire into the house. Generally, if you have a choice between a stone or concrete patio versus a wood or plastic deck, it is better to choose the patio. Similarly, a non-flammable fence made of wire and steel T-posts is preferable, but if a wooden fence is built, design it so that grass and weeds growing along its base can be easily trimmed.

FIRE-RESISTANT CONSTRUCTION MATERIALS AND TECHNIQUES

Exterior Walls

Wood and vinyl

Vinyl wall coverings are not appropriate for home construction in wildland fire environments. Vinyl melts at relatively low temperatures. Most wood, wood composite, and wood shingle exterior wall coverings are also risky for use in fire-prone environments. These coverings are better used where wildland fire is not an issue. This is especially true for hardboard and cedar shingle wall coverings, both of which quickly failed in flame exposure tests. An exception is wood treated with fire retardant, especially if tongue and groove or other 'tight' building techniques are employed, but the retardant chemicals also have a limited lifespan and may need to be reapplied. The sheathing that underlies wall coverings is also a factor. In laboratory fire tests, Oriented Strand Board (OSB) failed in about 80% of the time that plywood failed.

Living with Fire: fire-resistant construction materials enable people to live safely and sustainably in fire-dependent grassland, brushland, and forested ecosystems.

Fiber-cement

This includes cement and wood fiber mixes such as "Hardie Plank," usually applied as horizontal lap siding. The type of lap is important, with joints that interlock or tongue-and-groove performing better than plain bevel lap. Plain bevel lap is not as good since tests showed that flames penetrated walls within one minute, while shiplap resisted flames over 20 minutes. Several things can be done to assure that these cement/fiber siding boards don't separate with age or various kinds of trauma. One manufacturer recommends leaving an eighth of an inch gap between planks and adjoining wooden members. This avoids warping when the wood members swell up during wet weather. Some plank manufacturers advise homebuilders to seal between the planks with caulk. This also makes sense for reducing the likelihood of fire entry into the house. These planks are roughly 80 percent cement. They will not burn at forest fire temperatures.

Stucco

Stucco is probably the best material for WUI wall construction. Stucco is simply a fine grade of cement, a sort of artificial stone that does not burn and is not a good heat conductor. An added plus for homeowners is that it is low maintenance in most western climates. One concern, though, is that protruding wooden beams can wick fire through stucco walls and ignite the interior of homes.

Concrete wall systems

At first glance concrete wall panels would seem to be fireproof systems, but these systems are relatively new on the market; consequently, research on their efficacy in resisting wildfire damage is not yet available. One system uses large amounts of plastic foam that may actually present some problems in a wildfire situation.

In summary, covering walls with stucco or cement/fiber appears to be an economical way of reducing the flammability of exterior walls. Underlying sheathing should be made of plywood if possible.

Roofs

There are numerous roofing materials that will look good and keep the weather out, but only a few materials will resist ignition from wildfires.

Underlayment and sheathing are important. No matter which type of roofing is chosen, use one of several nonflammable underlayments that are on the market. Also, there is considerable evidence that if fire does penetrate the roof surface, plywood sheathing will not fail as quickly as oriented strand board and other composite products. So consider plywood for roof sheathing.

Slate
This is very expensive, and the product is heavy enough that roofs must often be specially designed to bear the weight. For those who can use it, slate offers excellent fire protection.

Tile
Concrete tile passed a flaming brand test. Polymer modified fiber-cement also passed.

Metal
Metal roofs have an excellent record in forest fire situations. Not only are they composed of a material that will not burn, they are fairly 'slippery' and tend to shed flammable debris before it can build up. Metal roofs are moderately priced.

Composition
This is the classic three-tab asphalt roofing. One popularly used brand passed a 20-minute firebrand test without fire penetration.

Fiberglass
This is similar to three-tab, but the material is fiberglass. It has a Class A rating: flames from a firebrand did not penetrate a fiberglass shingle roof.

Cedar Shake Roofs
These are absolutely the worst choice for roofing in the wildland/urban interface. They are easily ignitable, highly flammable, and catch needles too well. According to research on home ignitability by Jack Cohen of the U.S. Forest Service's Fire Sciences Lab, if all a homeowner can do is to replace a wooden shake roof with a roof made of nonflammable materials, they raise the probability of their home surviving by 90 to 95 percent.

In summary, for most price ranges, metal, various tile products, fiberglass, or composition will work for roofs. The ability of metal to shed needles and leaves makes it an excellent choice for WUI roofs. Again, a non-flammable underlayment and plywood sheathing may also increase home fire resistance.

Windows

Windows are defined here as both the frame material and the glass. Tests at the University of California Forest Products Laboratory show that the glass is the most important factor when considering fire penetration.

Glass
Glass Double pane (thermopane, etc) performed far better than single pane. It is not too expensive, and saves on heating and cooling bills. It works because most windows fail when a sudden spike in the temperature of the exposed glass pane cannot equalize with the glazed portion (the part of the glass covered by the wood or metal glazing). The double panes slow down this sudden heating. Often the outer pane fails, but the inner pane does not shatter and thus embers cannot blow into and ignite the house. Tempered glass is quite expensive but performs

better than regular annealed glass.

Window frames

Whether vertical or horizontal, frames tend to fail at the interlock between windows. Some homeowners have constructed metal shutters to place over windows in the event of a fire. This is expensive, and is very effective, but only if people are present and forewarned in time to install the shutters. Double pane windows with wood, wood clad with aluminum, or fiberglass frames did well in flame tests. Anecdotal evidence from the 1988 Florida wildfires showed that vinyl frames can melt, causing the glass to fall out and allowing flames to enter the interior of houses.

Vents

Vents help control of moisture coming up from the ground during winter precipitation and accumulating inside the house structure. Most codes are standardized, so vents are frequently sized to eliminate moisture problems in climates ranging from warm and wet Florida to cold and snowy Minnesota, as well as the high desert area of Bend, Oregon. In many cases these codes provide much more venting than is needed in the arid west. For homes located high in the westside Cascades where there is lots of rain and snow, having a large amount of venting is fine. But for homes located down in the dry mixed-conifer or pine country, consider using the minimum acceptable square footage of venting.

Friendly Fire: the sooner communities are prepared for wildland fire, the sooner ecosystems can be restored with prescribed fire—the best insurance against severe wildfires.

Minimum venting is recommended because vents are vulnerable to ember wash. Ember-wash is what often happens when the flaming front of a wildfire is pushed by strong winds. Thousands of glowing embers are carried through the air by the force of the wind and by the convective air rising off the flaming front. Most of these embers are so small that they have little fuel, release very little heat, and tend to go out almost immediately. The larger the size of the ember, however, the longer it can sustain glowing combustion. If a larger ember gets pushed into a soffitt vent and lands on some drill shavings or a similar material inside an attic, the house can ignite and burn. Sometimes the advent of flaming combustion inside a house can occur hours after the flaming front has passed.

Perhaps the best mitigation for these vents is screening. The author has not seen research on this, but has the knowledge derived from many years on the fireline having embers land in his ears and down his neck to learn that the larger the ember, the more heat it can generate—and it only takes one ember landing in the wrong place to ignite a house. Based on this experience, the author decided to screen his own soffitt vents and crawlspace vents with 1/8" steel mesh. Some county code enforcers will frown on this, as they worry that dust, subsequent paint jobs, and other factors will tend to clog 1/8" mesh. Some codes actually call for 1/4" mesh, as much to screen out insects and leaves as for fire protection. In our opinion, 1/4" mesh is inadequate, and suggest that 1/8" mesh steel screen (if codes allow) be used, but they must be cleaned occasionally, and should not be painted.

All forms of vents on the underside of eaves (strip, freeze block, etc) in both boxed and open eave designs will admit flames and superheated air. That is why it is so important to keep the flammable vegetation, decks and woodpiles away from the house.

CONCLUSION

Each year home losses to wildfire gets worse because the number of new homes built and the amount of acres burned by wildfire increase. While most policymakers have focused on fire prevention, it is important to realize that fire is essential to maintain the natural landscapes that people love. Fire reduces hazardous surface fuels, recycles nutrients, regenerates plants, and stimulates biological diversity. The modern attempt to exclude wildland fires has degraded many of the ecological values that attract people to live, work, and recreate in rural and wildland areas. In many cases, more prescribed and wildland fire is needed in order to protect communities from severe wildfires and to restore the vitality and beauty of America's fire-sculpted landscapes.

Unfortunately, many low-intensity wildland fires that could be managed for community protection and ecological restoration benefits are often aggressively suppressed, and opportunities to applied prescribed fire are missed, solely because vulnerable homes are located in the area. We cannot "fire-proof" forests, grasslands, and shrublands that depend on fire, but we can design and build homes and communities that are fire-resistant. As Stephen Quarles and Jack Cohen's research has revealed, homes with low ignitability can survive high-intensity wildfires, yet highly ignitable homes can be destroyed even during lower-intensity wildfires. When building or renovating homes located in fire-prone areas, it simply makes sense to use fire-resistant construction materials.

Although the largest and most destructive wildfires have historically been located in the western U.S., wildfires burn in every state. Additionally, taxpayers across the country are spending billions of dollars on both emergency suppression and disaster recovery efforts. Most importantly, firefighters are putting their lives at extra risk attempting to protect essentially indefensible homes from wildfires. For all these reasons, this is a national issue and it is in everyone's interest to reduce the ignitability and flammability of homes and other built structures.

By using some of the fire-resistant materials in this Homeowner's Guide along with managing the vegetation and fuels on their properties, homeowners can become active partners with wildland firefighters to help protect homes and communities from wildfire damage. The sooner we create fire-resistant homes, the sooner we can restore fire-dependent ecosystems. In so doing, we can end the fear and learn to live with wildland fire.

LINKS

www.fusee.org - This is the website of Firefighters United for Safety, Ethics, and Ecology (FUSEE), a nonprofit organization of current and former wildland firefighters, other fire management professionals, and rural homeowners. FUSEE promotes a natural partnership between wildland firefighters and rural homeowners. The "Frontline Home Safety" section includes a lot of interesting and useful information for WUI residents, and hosts links to several related sites for more information.

www.firewise.org - This is a great website, with lots of tips for vegetation management around homes. The "Firewise Construction Checklist" is very good, but does not offer specific information on construction materials.

www.nfpa.org - This is the website of the National Fire Protection Association. You can order NFPA 1144, which is a model code for WUI fire prevention.

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