TOPIC BRIEF

WILDFIRE TAKE-AWAYS: *Construction Best Practices in Wildland-Urban Interface Areas*

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In 2018, the Camp Fire tore through Paradise, CA, destroying 18,804 structures in a matter of hours. In the midst of this devastation, a mystery emerged—why had some homes survived while others were reduced to ash?

Post-fire analyses revealed a clear formula for wildfire resilience: building codes, material choices, and land management made the difference between survival and destruction. Homes built after 2008, under California's Chapter 7A wildfire-resistant codes, were more than three times more likely to survive than those constructed before 1997. Class A roofs, ember-resistant vents, noncombustible siding, and multi-pane windows proved critical in deflecting heat and embers, while defensible space and community-wide firebreaks helped slow the spread. As Paradise continues to rebuild from the Camp Fire—and as areas like Altadena and the Palisades are just beginning this journey—these hard-earned lessons will shape a future where homes and communities stand stronger against wildfire threats, especially in areas where dense human development is closest to natural fuel sources.

RESPONDING TO RISK: WILDLIFE-URBAN INTERFACE AREAS

The wildland-urban interface (WUI) refers to the geographic area where structures and other human development meet or intermingle with wildland or vegetative fuels. During extreme weather conditions like severe drought, these areas are susceptible to uncontrolled fire spreading through vegetative fuels, exposing and possibly consuming structures. The risk of a wildfire in these regions is classified into Fire Hazard Severity Zones (FHSZs).

FHSZs are classified as having moderate, high, or very high risk levels depending on the fuel load, terrain, and critical fire weather frequency (measured in days per year). Structures located within these zones are subject to specific building codes and construction standards designed to minimize the potential for fire damage and improve ignition resistance.

The following guidelines are based on research and knowledge from throughout the fire protection engineering industry, incorporating codes, standards, and mitigation recommendations from various trusted sources. These regulations outline specific building construction requirements and best practices for structures located in WUI areas and FHSZs. The primary objective is to reduce the potential for wildfire damage and prevent the spread of flames to buildings. Enhancing a building's ability to resist flame intrusion and slow the impact of burning embers contributes to minimizing losses and improving overall fire resilience in vulnerable areas.

Wildland-urban interface (WUI) areas pose wildfire threats where human development abuts undeveloped vegetation.

FIRST LINE OF DEFENSE: ROOFS

Imagine two homes standing side by side in Paradise, CA, during the 2018 Camp Fire. One, with a well-maintained Class A roof and enclosed eaves, survived with minimal damage. The other, with an aging wood shake roof and debris-filled gutters, was completely consumed by flames. This real-world contrast highlights a crucial fact: a home's roof is its first line of defense against wildfire. Using Class A fire-rated materials (ASTM E108/UL 790), keeping the roof clear of debris, and ensuring that eaves and vents are ember-resistant can dramatically increase a structure's chances of survival. However, even the best roofing materials degrade over time, so weathering protocols like ASTM D2898 help ensure long-term performance.

Key take-away

A fire-resistant roof is about more than just what it's made of. It's also about how well it is maintained.

Best Practices for Roofs

Roofs in WUI and FHSZ must be constructed using materials and systems to reduce the risk of ignition. A Class A roof assembly, as defined by ASTM E108 or UL 790, is required for roofing materials. Materials tested to these standards and listings can withstand severe fire conditions. However, it is important to note that the effects of weathering are not considered during factory testing, so additional weathering protocols such as ASTM D2898 must be followed to account for environmental factors.

In addition to using fire-resistant materials, roof maintenance plays a crucial role in performance during a wildfire. Damaged or broken pieces of roofing materials should be quickly replaced to maintain the integrity of the roof. Debris, including litter and vegetation, should be regularly removed from the roof to prevent the accumulation of combustible material.

Open roof eaves, enclosed roof eaves, exterior porch ceilings, floor projections, underfloor protection, and the underside of appendages should be of noncombustible materials, ignition-resistant materials, or fire-retardant-treated wood to prevent ember intrusion.

Materials used in roofing and eave systems must be approved for a minimum of a 1-hour fire rating in accordance with ASTM E119 or UL 263. Additional testing standards, including ASTM E2957 and SFM Standard 12-7A-3, provide requirements for materials to meet the necessary performance criteria for fire resistance.

Roofs should be well maintained and made of fire-resistant materials.

LAST LINE OF DEFENSE: EXTERIOR WALLS

When the Almeda Fire tore through Talent and Phoenix, OR, in 2020, entire neighborhoods were reduced to ash in just hours. But in the aftermath, an unmistakable pattern emerged: homes with noncombustible siding like fiber cement or stucco were far more likely to remain standing compared to those with traditional wood or vinyl siding. Investigators found that radiant heat and ember exposure ignited combustible wall materials, leading to fire spreading rapidly. Meanwhile, structures built with fire-rated walls (ASTM E119, UL 263) resisted ignition long enough to avoid total destruction.

Key take-away

When fire approaches, exterior walls are the last major defense before flames reach the interior. Choosing noncombustible or ignition-resistant materials can mean the difference between a home that withstands the fire and one that fuels it.

Best Practices for Exterior Walls

Exterior walls of structures located in WUI areas and FHSZs must be designed to withstand the high risks posed by wildfires. A minimum 1-hour fire rating is required for exterior walls to provide a barrier against the spread of flames and heat. Materials used for exterior walls must be one or more of the following: noncombustible, ignition-resistant, fire-retardant-treated wood, or heavy timber. These materials help slow the ignition and spread of fire and maintain structural integrity under heat exposure.

Exterior walls undergo rigorous testing to determine their fire resistance. Testing standards such as ASTM E119, UL 263, ASTM E84, UL 273, and NFPA 268 assess the fire performance of these materials to show they meet fire safety standards. By adhering to these codes and testing protocols, structures in WUI and FHSZ can reduce the risk of fire damage.

Noncombustible exterior walls can help withstand the risks posed by wildfires in WUI areas.

HEAT-INDUCED RISK FACTORS: DOORS AND GLAZING

During the 2017 Tubbs Fire, which devastated parts of Santa Rosa, CA, post-fire assessments revealed a striking pattern: many homes ignited not from direct contact with flames, but through heat-induced window failures and compromised doors. As the firestorm approached, homes with multi-pane, tempered glass windows and solid-core or metal doors fared significantly better than those with single-pane windows and hollow-core doors.

Investigators found that single-pane glass shattered within minutes, allowing flames and embers to enter, while multi-pane and tempered glass resisted heat much longer, often keeping homes intact even when surrounded by burning structures. Similarly, hollow-core doors failed rapidly, whereas homes with solid-core or metal doors (minimum 1 3/4 in. thick, NFPA 252 tested) provided crucial protection against heat and embers.

Key take-away

Doors and windows aren't just entry points for people—they can also be entry points for fire.

Best Practices for Doors and Glazing

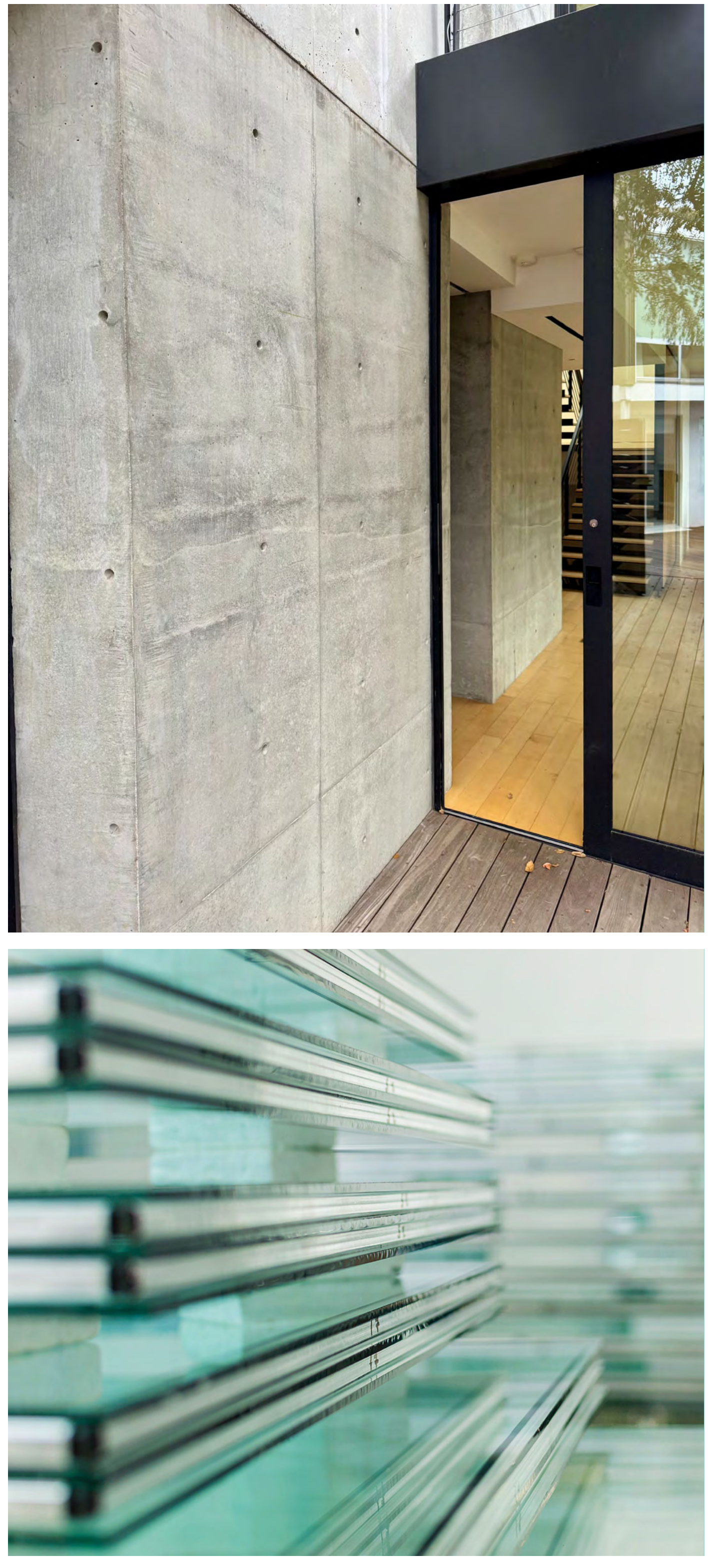
Using multi-pane tempered glass, fire-rated doors, and noncombustible framing gives structures a better chance of withstanding a wildfire, preventing interior ignition, and providing more robust conditions relative to protecting against building-to-building fire exposure.

The design of doors and glazing for structures located in WUI areas must incorporate materials and construction methods that enhance fire resistance. A minimum of a 20-minute fire resistance rating is recommended for doors and glazing, with higher ratings required if the exterior wall rating exceeds 1 hour.

For doors, solid core or steel options with a minimum thickness of 1 3/4 in. are ideal, as they offer superior strength and fire resistance compared to other materials. Noncombustible framing should be used to further reduce the risk of ignition.

Glazing should be constructed of multi-pane systems with at least one layer being tempered. Multi-pane and tempered systems are more durable and can withstand higher temperatures before failure, making them a key component in fire-resistant design. Additionally, glass block units can be used for their enhanced durability and fire-resisting properties.

All materials being used for doors and glazing should be appropriately listed. Testing for doors and glazing must be in accordance with established standards, such as NFPA 252, NFPA 257, and SFM Standard 12-7A-2. These tests determine that materials meet the necessary performance criteria for fire resistance.



Fire-rated doors (top), tempered glass (bottom), and noncombustible framing can help structures better withstanding wildfires.

EMBER-RELATED RISKS: VENTS AND CHIMNEYS

The 2003 Cedar Fire in San Diego County remains one of California's most destructive wildfires, consuming more than 273,000 acres and 2,800 structures. Investigators found that one of the most common failure points in these homes was ember intrusion through vents and chimneys. As the firestorm advanced, superheated embers entered through attic and crawl space vents, igniting insulation and interior materials long before direct flame contact.

Post-fire studies showed that homes with 1/8 in. mesh ember-resistant vents (ASTM E28886 tested) had a much lower rate of attic ignition compared to homes with larger, unprotected vents. In contrast, open chimney flues and unprotected vents acted as pathways for embers, accelerating fire spread inside homes.

Key take-away

Vent and chimney protection is just as important as exterior walls or roofs.

Best Practices for Vents and Chimneys

Using fine-mesh ember-resistant vents, properly maintained chimneys, and spark arrestors significantly reduces the risk of embers igniting the home from the inside out. The lesson from the Cedar Fire is clear—even homes with fire-resistant exteriors can be lost if embers find a way inside.

Vents and chimneys are at risk for providing embers and smoke a way into a structure during a wildfire. The following criteria should be followed to minimize the risk of a fire spreading inside a structure.

Vents must be tested in accordance with ASTM E28886 and meet the specific performance requirements. During the ember intrusion test, vents must prevent flame ignition of cotton material. During the integrity test portion of the flame intrusion test, vents must not exhibit flaming ignition. The temperature on the unexposed side of the vent must not exceed 662 °F.

Chimneys need to be maintained and protected to reduce the risk of fire. Best practices include regularly removing debris to prevent the accumulation of combustible material, which can increase the potential for fire. Installing a spark cap is another preventative measure, as it contains embers and reduces the risk of them igniting nearby fuels. Both chimneys and vents can have wire mesh coverings no larger than 1/8 in. or 1/16 in. to prevent the intrusion of embers.

Vents and chimneys should be limited to 144 sq ft in size. Additionally, they must be tested in accordance with the established standards, which include UL 103, UL 127, and ASTM E28886.

Vents and chimneys are at risk for providing embers and smoke a way into a structure during a wildfire.

ACKNOWLEDGING TEST LIMITATIONS

Factory tests cannot fully replicate the unpredictability, intensity, or other complex factors of wildfires. These practices are designed to help mitigate potential damage in the event of a wildfire, based on the best available expertise, professional testing, and established standards, regulations, and guidelines.

BUILDING FOR A FIRE-RESISTANT FUTURE

Learning from past wildfires underscores the importance of proactive fire-resistant design, construction, and maintenance. Implementing fire-resistant materials, following established building codes, and maintaining defensible space are critical strategies to reduce wildfire risks. While no solution guarantees immunity, these measures provide a solid foundation for resilience in an increasingly fire-prone world.

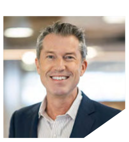
ADDITIONAL RESOURCES

CBC Chapter 7A: Materials and Construction Methods for Exterior Wildfire Exposure

2024 IWUIC Chapter 5: Special Building Construction Regulations

SFPE WUI Handbook for Property Fire Risk Assessment & Mitigation

NFPA 1140 Standard for Wildland Fire Protection Chapter 25



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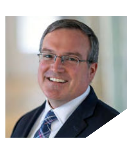

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