



# Marshall Fire Mitigation Assessment Team: Homeowner's Guide to Reducing Risk of Structure Ignition from Wildfire

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## 1. Introduction

On December 30, 2021, a wind-driven wildfire affected over 2,000 residential structures and several commercial facilities in unincorporated Boulder County, the City of Louisville, and the Town of Superior, Colorado. Data gathered after the fire highlighted that homes were vulnerable to ignition at various features including the exterior envelope of the structure and associated attachments.

Because of the unique nature of the incident, where extreme winds coupled with long term drought, high temperatures, and limited wildfire regulatory adoption, a fast-moving low-intensity grass fire became a highly destructive urban fire directly and indirectly impacting several communities and greater Boulder County area. The Federal Emergency Management Agency (FEMA) deployed its first-ever wildfire Mitigation Assessment Team (MAT) to evaluate building performance during the fire. The MAT was deployed to Louisville, Superior, and unincorporated areas in Boulder County, Colorado, to evaluate damaged homes and commercial structures. MAT members evaluated components and systems of primarily residential structures to determine the effectiveness of various building materials, design, and construction practices for wildfire resiliency. The MAT used the information gathered to evaluate how wildfire-urban interface (WUI) building codes and standards, as well as design, construction, and defensible space practices can be improved to increase community wildfire resilience. This is important as the landscape is continuously evolving due to climate change and putting more communities at risk.

## 2. Purpose

This document provides homeowners with steps they can take now to decrease the likelihood their homes will ignite due to direct flame contact, ember intrusion, or hot gases from wildfires at various physical vulnerabilities throughout the exterior envelope of the house. Specifically, it provides information about some measures that homeowners can take to address vulnerabilities at joints, gaps, vents, and attachments such as decks and fences.

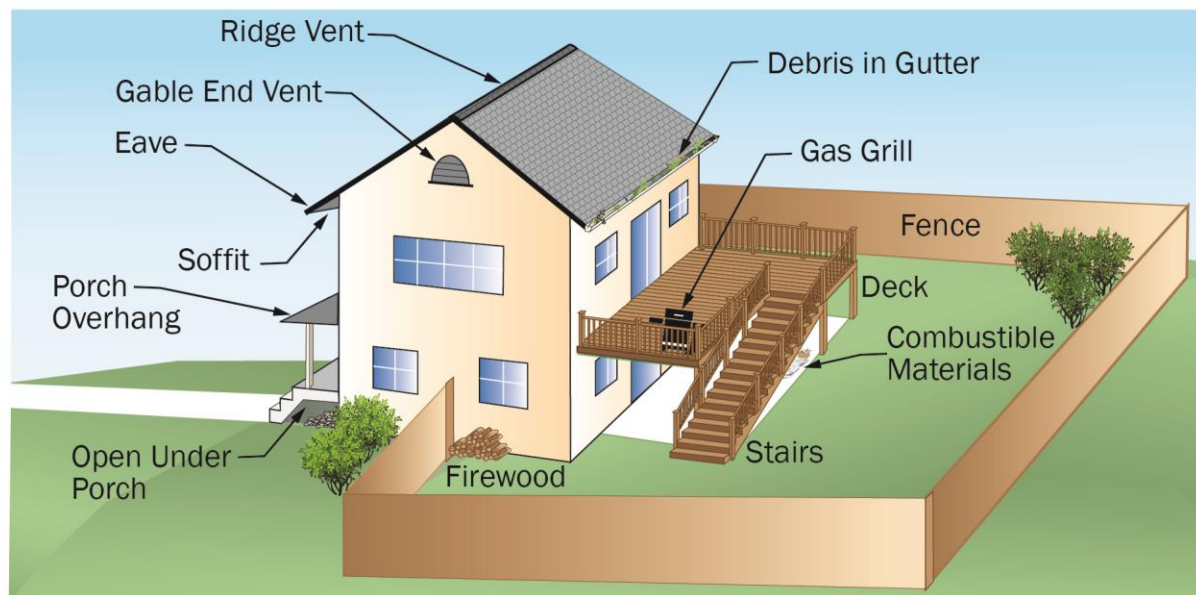
## 3. Key Issues

Note: This document uses the term “embers” to refer to both “firebrands” and “embers.” Sometimes scientific literature distinguishes between the two terms where “embers” are “any small, hot, carbonaceous particle” and “firebrands” are embers that are “airborne and carried for some distance on an airstream” (Babrauskas, 2018).

- When components and assemblies of homes such as walls, roofs, windows, doors, and siding systems are connected they leave exposed surfaces, form joints or spaces at the connection points. These joints and spaces help accommodate building movements and construction tolerances. They also are places where vegetative debris (e.g., leaves, needles, grass clippings, twigs, branches, etc.) tends to accumulate. While current building codes do require fire-resistant construction, homes constructed following older codes may have exterior walls that are susceptible to fire depending on the construction and/or materials used to construct them.

Single-family homes typically do not have exterior walls that are built to resist wildfire, which means they have the potential to allow surfaces to be exposed to embers, flames, and hot gases or enter the home through the exterior envelope (Figure 1).

- Vents in roofs, walls, and crawl spaces provide the air circulation needed to minimize moisture buildup that can lead to significant damages over time. These vents, if not sealed, provide a pathway for embers to enter the house, resulting in possible ignition inside the structure.
- Current research indicates that decks, porches, balconies, and exterior stairs are often constructed of non-fire-resistant materials which embers can ignite. Vegetative debris can accumulate on or under these structures. These structures can ignite when directly exposed to embers or direct flaming. Because they are often adjacent or attached to the vulnerable components (e.g., glass doors and windows) of the house, once they ignite, fire can spread to the house itself.
- Fences constructed from combustible materials and having joints or spaces between components (such as post-and-board fences) can allow embers to collect in the joints and gaps. Flames can travel horizontally along combustible fences when ignited, acting as a “wick.” When the fence is attached to the home, these flames can then ignite the house itself. Fences within the first five feet of the house pose the greatest risk of flames igniting combustible siding or embers and flames igniting the under-eave area and the roof edge.



**Figure 1. Many components of a home can be susceptible to ember and hot gas intrusion from a wildfire, which can result in the home igniting.**



## DEFINITIONS

**Fire resistance** – The property of materials or their assemblies that prevents or retards the passage of excessive heat, hot gases, or flames under conditions of use. (International Building Code (IBC), 2021)

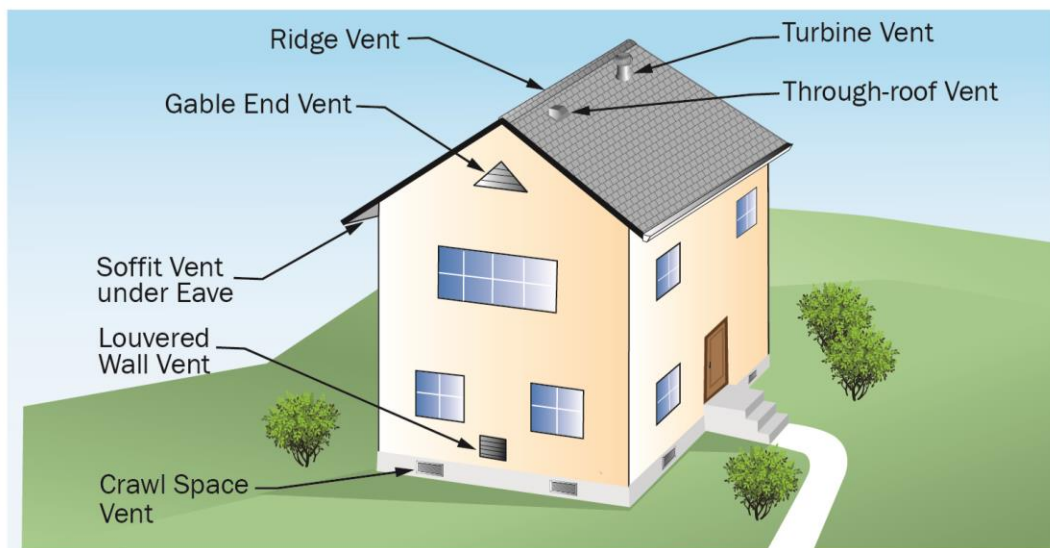
**Fire-retardant-treated wood** – Wood products that are treated with chemicals so that the treated wood does not support combustion, and its burning rate is limited when flame is applied. (Minnesota Department of Labor and Industry, no date)

**Ignition-resistant building material** – A type of building material that resists ignition or sustained flaming combustion sufficiently to reduce losses from wildland-urban interface conflagrations under worst-case weather and fuel conditions with wildfire exposure of burning embers and small flames. (IWUIC, 2021; ASTM E84; ASTM E2786)

**Noncombustible (building material)** – Material of which no part will ignite and burn when subjected to fire; any material conforming to ASTM E136 meets this requirement. Also includes material having a structural base of noncombustible material as defined previously with a surfacing material not over 1/8-inch thick, which has a flame spread index of 50 or less. (IWUIC, 2021)

## 4. Vents and Openings (including soffits, ridges, crawl spaces and gables)

Vents help create proper air flow in interior unoccupied building spaces such as attics and crawl spaces, which help to reduce moisture and hence moisture-related problems such as mold (Figure 2). They also provide an exit for exhaust from heating, ventilation, and air conditioning (HVAC), and plumbing systems. In wildfire conditions, these openings can provide an entrance for embers and hot gases to be blown or pulled into the house, which can result in the ignition of interior contents.

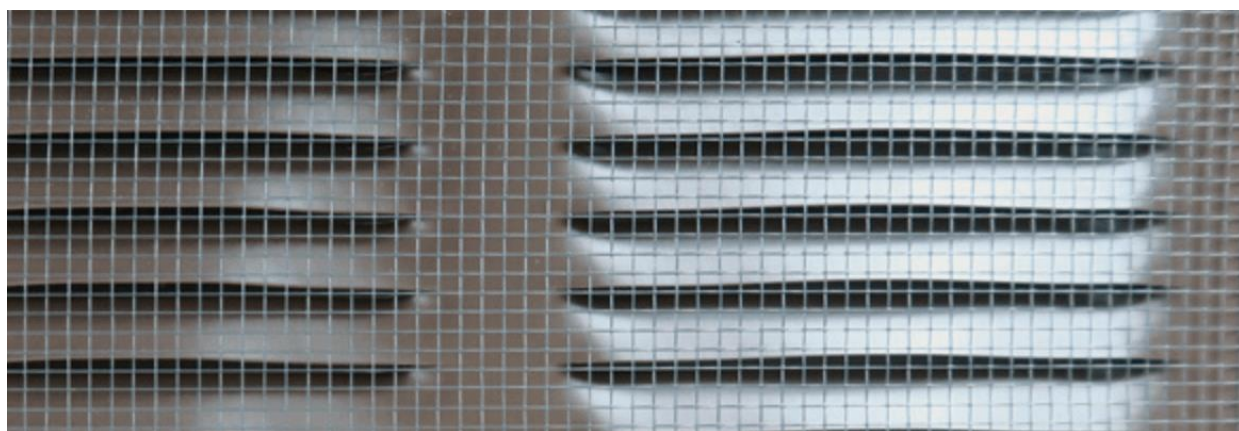


**Figure 2. Vents can provide an entrance for embers to enter a house.**

Vents containing metal mesh with 1/8-inch or less openings can help reduce the possibility of embers entering the house through the vent. Metal mesh with 1/16-inch openings is acceptable but will more easily accumulate debris so it needs to be cleaned more often than vents with larger openings; however, all vents should be cleaned regularly. Taking the following measures can help reduce the likelihood of embers and hot gases entering the house through vents.

- Check the flashing around vents on the roof. Replace missing, loose, or corroded flashing using noncombustible screening materials. Seal using a fire-resistant caulk, non-combustible mortar, or fire-rated expanding foam. Online videos can provide additional guidance or use a roofing contractor to secure the flashing around the vents.
- Turbine vents can help keep embers out, however, it is important to attach a piece of 1/8-inch mesh to the bottom of the roof sheathing at the opening for the vent (IBHS/NFPA, 2022).
- Consider replacing existing exterior wall, crawl space, and foundation vents with noncombustible flame- and ember-resistant vents (Figure 3). The California Department of Forestry and Fire Protection (CalFire) Building Materials Listing Program maintains a Wildland Urban Interface (WUI) Products Handbook [online](https://osfm.fire.ca.gov/media/5e4drz1r/2021-sfm-wui-listed-products-handbook-12-14-2021.pdf) (<https://osfm.fire.ca.gov/media/5e4drz1r/2021-sfm-wui-listed-products-handbook-12-14-2021.pdf>) that contains a listing of products that meet the State's Building Code requirements for "vents for WUI." Many of these products and materials included in the listing are appropriate for use outside of California, as are recommendations included in their [Low-Cost Retrofit List](https://osfm.fire.ca.gov/media/p0elt0sp/low-cost-retrofit-list-update-2_17_22.pdf) ([https://osfm.fire.ca.gov/media/p0elt0sp/low-cost-retrofit-list-update-2\\_17\\_22.pdf](https://osfm.fire.ca.gov/media/p0elt0sp/low-cost-retrofit-list-update-2_17_22.pdf)).
- Add a layer of 1/8-inch or 1/16-inch opening corrosion-resistant metal wire mesh behind or in front of the vent opening in existing exterior vents.

- Replace existing non-fire-rated louvered wall vents such as those for clothes dryers with fire-rated, noncombustible, or fire-resistant wall louver vents minimize the entry of embers from entering through the vent. Be sure louvers open and close properly. Do not use mesh in louvered dryer vents.
- When replacing or reinstalling vents, use a fire-resistant caulk to seal around the edges of the vent to prevent water and ember intrusion between the vent and the exterior wall.
- This [video](https://www.youtube.com/watch?v=kEZPdnwdmGY) from Fire Safe Marin shows how to repair or replace foundation vents. (<https://www.youtube.com/watch?v=kEZPdnwdmGY>)



**Figure 3. Installing 1/8-inch noncombustible mesh screening over exterior vents will help reduce the likelihood of ember intrusion. (IBHS, no date)**

## 5. Gaps at Joints and Interfaces

Detailing at joints and interfaces of building components throughout the exterior envelope of a home, such as joints between skylights and roofs, gutters and roofs, windows and walls, and siding and foundations often leave exposed surfaces and can result in gaps or spaces where the two components join together. The exposed surfaces and gaps can leave these areas vulnerable to ember and flame intrusion as well as smoke, soot and ash infiltration. Embers entering through these spaces can become trapped between the outside and inside walls of the house, allowing the fire to spread in this space between walls. In addition, combustible debris such as dried vegetation can accumulate along linear joints and in gaps and pose an additional fire threat. Using the following measures can help reduce the likelihood of embers, hot gases, smoke, soot and ash entering the house through joints and gaps.

- Cover exposed edge surfaces of combustible material with a non-combustible material to minimize the chance of direct exposure to excessive heat, embers, or flame. An example would be to wrap the exposed edges of roof, wall, or floor sheathing material with corrosion-resistant (galvanized) metal flashing and seal with intumescent caulk, which swells when heated to seal gaps.



- Use a fire-resistant sealant, caulk, or expandable foam to seal the gaps between wall and frame joints around skylights, windows, doors, and garage doors. This helps to protect against entry of embers, hot gases, smoke, soot and ash.
- Multiple opportunities exist to reduce the exposure of roofs to ember intrusion and ignition. Homeowners might prefer to work with a contractor to implement these strategies, some of which are listed below.
  - Confirm that corrosion-resistant metal flashing is installed around chimneys. If flashing is not present, is not corrosion-resistant, or is in poor condition, install, repair, or replace the flashing.
  - Where there are gaps in roof-to-roof joints (ridges), seal the roof ridges at their terminations. Generally, a mortar mix is easy to use in these locations for tile or other roofing material where mortar is appropriate.
  - Install corrosion-resistant metal flashing at the roof edges and where exterior walls meet roofs. For profile-tiled roof edges, install bird stops or mortar at the open ends of tiles.
  - Install noncombustible gutters. If gutter guards are used to minimize the accumulation of leaves and debris in the gutters, they should be noncombustible.
- At wall expansion joints and where roof expansion joints are visible, verify the joint protection and flashing are in good condition. Consider replacing combustible expansion joints with noncombustible materials.
- Verify weather stripping around doors and operable windows is in good condition and provides a weather-tight seal. Consider replacing existing combustible weather stripping with fire-rated weather stripping to help protect against entry of embers, hot gases, smoke, soot and ash.
- Block gaps in siding with firestopping materials such as mineral wool or fire-resistant caulking/sealants (Figure 4).



**Figure 4. Homeowners should block gaps between siding and foundations (such as the one pictured here) using firestopping materials such as mineral wool or fire-resistant sealants to prevent embers, hot gases, and flames from entering and becoming trapped.**

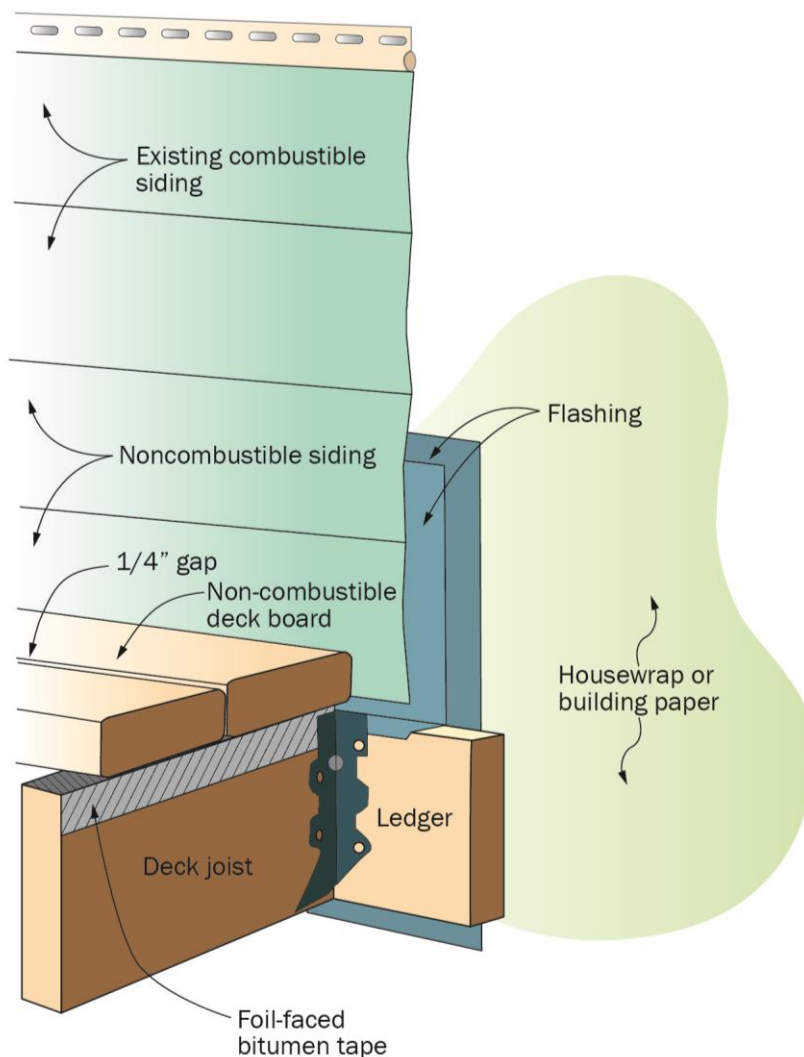
## 6. Decks, Porches, and Balconies

Existing decks, porches and balconies may be constructed from a variety of materials, including but not limited to softwoods, hardwoods, plastic composites, and aluminum. They usually are directly attached to the exterior walls of the house and, if constructed from combustible materials, can provide a pathway for fire to ignite the house. In traditional construction, the boards that form the walking surface of these structures are usually spaced about 1/8-inch apart. Gaps between the planks and between the structure and the house will trap embers. Decks, porches, and balconies are often elevated above ground, which makes them susceptible to wildfire from both above and below. The upper surface can ignite from ember exposure while the under-surface can ignite as a result of flame exposure. Homeowners can take steps to improve the fire-resistance of decks, porches, and balconies to protect their homes.

- If the existing deck frame is structurally sufficient, consider removing the existing deck boards and installing new decking using ignition-resistant building materials such as aluminum, steel, autoclaved aerated concrete, noncombustible tile, or fire-retardant treated wood. Composite deck boards should be used only if the manufacturer provides documentation that they are noncombustible. Some decking such as metal can be installed without gaps, decreasing the

circulation of oxygen that feeds the fire. If new surfaces are installed with gaps between the boards, the gaps should be  $\frac{1}{4}$ -inch.

- If the existing decking will not be completely replaced, remove and replace combustible deck boards that are parallel to and within one foot of the adjacent exterior wall of the house with noncombustible deck boards having the same thickness as the rest of the decking (Maranghides et. al., 2022) (Figure 5).



**Figure 5. Replacing two to three courses/rows of combustible materials with noncombustible materials where a deck adjoins a house will help protect a house against ember ignition. Attaching foil bitumen tape at the joints between deck joists and deck boards and installing with a  $\frac{1}{4}$ -inch gap between deck boards will also increase the ember resistance of decks.**

- If the existing deck is constructed from combustible materials and the surface decking is being replaced, apply foil-faced self-adhering bitumen along the length and tops of the joists supporting the deck (Figure 5). Position the tape on each side of the joist near the top where the deck boards are attached.

- If existing siding is combustible, remove the bottom two to three courses of siding and replace them with noncombustible siding (Figure 5). If this is not possible or desirable, install a metal flashing strip approximately 18 inches tall extending from the top of the deck over the existing siding. Be sure to tuck the top of the flashing behind the siding to prevent water from seeping between the flashing and the siding.
- Replace combustible railings with railings constructed from noncombustible materials.
- Ignition-resistant building materials need to maintain their performance after they have weathered. Obtain information from the materials' manufacturer regarding fire performance after weathering. Replace deteriorated components before they lose their fire-resistance.
- Enclose open spaces beneath elevated decks and stairways using ignition-resistant or noncombustible materials. Enclosures should extend the full height of the structure all the way to the ground surface, except when the deck is constructed over a descending slope greater than 10%, in which case the space should be enclosed to within six inches of the ground. To prevent a build-up of moisture that could result in decay, install ember and flame-resistant vents to avoid moisture degradation issues in the under-deck area (e.g., corrosion of metal fasteners and fungal decay in wood members).

## 7. Fences

Privacy fences are often constructed so they attach perpendicular to the home and extend to follow property lines. They can be constructed from a variety of materials and can include different designs. Soft woods such as cedar and redwood are often used for their aesthetic and ease of installation and maintenance; however, these types of wood can ignite easily when exposed to radiant or convective heat or embers. Hard woods are more ignition-resistant than soft woods but can still catch fire. Plastic or composite materials also are more ignition-resistant than soft woods but are susceptible to melting during a wildfire or grass fire. Regardless of the fence material, vegetative debris can accumulate along the bottom of fences, providing an additional source of fuel for fires. Debris and embers also can get trapped between slats in fences, resulting in ignition of the fence. In areas susceptible to wildfires and grass fires, fences constructed from combustible materials can inadvertently act as sources of fuel and “wicks” that draw the fire to the house. Homeowners can take steps to reduce the likelihood of home ignition from adjacent fences (Butler, Johnsson, et. al., 2022).

- Construct fences using noncombustible materials. At a minimum, use noncombustible materials for the first five feet of the fence that is in contact with the home (Figure 6). Fences parallel to the home should be constructed of noncombustible materials if a single fence is within 10 feet of exterior walls. Stone, decorative block, brick, precast concrete, and steel are all materials that can be used to construct visually pleasing fences that are also noncombustible.



**Figure 6. Noncombustible materials should be used to construct at least the first 5 feet of a fence attaching to a home.**

- Back-to-back fences along either side of a property line should not be used, as fire intensity and the spread of the fire along the fence is significantly increased using this configuration.
- Keep combustible landscaping at least five feet away from (combustible) fences. Instead, use ignition-resistant materials such as stone near fences constructed from combustible materials. (See Marshall Fire MAT document “*Homeowner’s Guide to Defensible Space*” for additional information.)

## 8. Maintenance

Homeowners should perform regular maintenance on their homes to protect against wildfire. There are several actions they can take to reduce the likelihood of embers and hot gas from entering their houses.

- Regularly remove vegetative and other debris from roofs, gutters, joints, where the foundation meets the ground surface, and along fences. Debris is a combustible fuel easily ignited by embers and often found directly on or next to the house, which increases the chances of home ignition.
- Clean vents periodically to remove debris so that each vent can perform its moisture management function properly.
- Do not store flammable materials in attics, on or under decks, under porches, or in crawl spaces.
- Remove vegetation near vents, exterior stairs, overhanging roofs and balconies, fences, and other places within five feet of the house (see the Marshall Fire MAT document *Homeowner’s Guide to Reducing Wildfire Risk Through Defensible Space* for additional information).



## 9. Renovations and Significant Retrofits

When undertaking a renovation or significant replacement such as a new roof, windows, exterior doors, or deck, ask the contractor about using ignition-resistant or noncombustible materials. This is particularly important when structures are in proximity, which can cause ignition through radiation. See Marshall Fire MAT document *Decreasing Risk of Structure-to-Structure Fire Spread in a Wildfire* for additional information.

## 10. Resources and Useful Links

- Babrauskas, V. 2018. Firebrands and Embers. In: Manzell, S. (eds) Encyclopedia of Wildfires and Wildland-Urban Interface (WUI) Fires.” Springer, Cham.  
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- Marahghides, A., Link, E., et. al. 2022. NIST Technical Note 2205 WUI Structure/Parcel/Community Fire Hazard Mitigation Methodology. National Institute of Standards and Technology. <https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2205.pdf>
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