

Resilient Retrofit, Repair, Rebuild & Recovery Resources

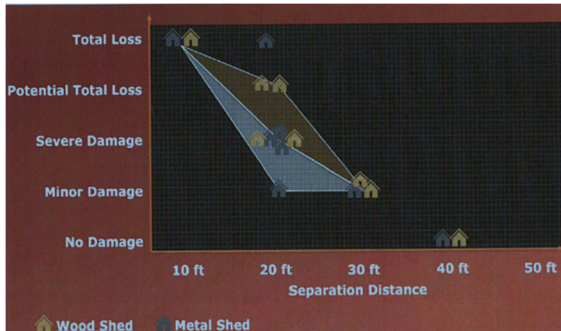
By: University of Hawai'i Sea Grant College Program, National Disaster Preparedness Training Center, Simpson Strong-Tie, Hawai'i Wildfire Management Organization.

Introduction

On August 8, 2023, wildfires tragically struck Lahaina and resulted in over 100 casualties, 2,200 structures that were destroyed, and an estimated \$5.5 billion in property damage. By comparison, Hurricane Iniki in 1992 damaged or destroyed 6,400 homes with approximately \$7 billion in inflation adjusted losses. Wildfires and hurricanes are two of the key hazards to be considered in Hawai'i and illustrate the need to plan and build for all hazards.

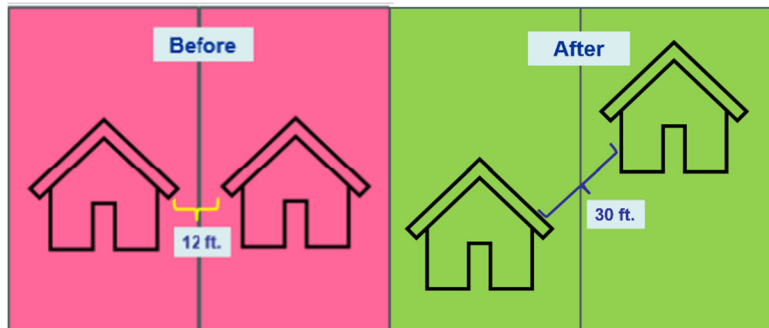
This brochure was written to provide best practices and helpful resources to homeowners so they can reduce hazard risk for existing homes through retrofit, as well as for those that need to be repaired or rebuilt. The guidance is general in nature and can apply to homes with similar features no matter what the county. As the homeowner or building owner contemplates the measures in this document, it is recommended that they first seek the advice of a licensed structural engineer or architect to determine applicability for their own building as each house is different. In addition, there may be local variations in building code requirements that may impact a repair or rebuild. Many of the measures may already be required under existing building codes. Even if they are not required, consider the practices as they will add value to the structure, make it more hazard resistant, and there is in general a large cost/benefit.

Importance of Defensible Space - Field assessments throughout the Lahaina area after the wildfire point out the benefits of defensible space to prevent wildfire spread. There have been many stories of the "Miracle House," located on Front St. that may have survived, in part, because of the defensible space around the perimeter of the structure (road, empty lot, ocean on 3 of the 4 sides).



One study by the Insurance Institute of Business & Home Safety (IBHS) after the fire indicated that structural spacing of less than 20 feet significantly increases the likelihood of fire spread once a wildfire has entered the community. When spacing is less than 20 feet, the intensity of fire exposure surpasses the tolerance of nearly all fire-resistant materials.

Creating Defensible Space - In the case of rebuilding, the county, homeowners, and licensed professionals can work together and be creative in attempting to make defensible space. To the left is a typical R1 housing 6,000 ft.² with typical 6-foot side setbacks. Typical arrangement of housing leads to 12 feet of building separation. By moving houses within the same lots and complying with all zoning requirements, the houses on the right can be separated by 30 feet. If this is not possible, change the configuration of housing elements so they don't align with



the neighbors. One example of creating space after a hazard event is the buyout of land at the Hilo Waterfront after the 1946 and 1960 tsunamis.

Defensible space not only includes the spacing of the home on the lot but ensuring that the area remains clear of all combustibles. This includes decks, accessory structures, fences and storage of combustibles. Where adequate defensible space is not possible, hardening of the home becomes imperative to resist fire spread.

Landscaping - Remove combustible dead or dry vegetation and other materials from your yard. Replace wood fences with a metal fence or rock wall. Remove low-lying branches from trees that can act as a ladder for fire to climb to the canopy of a tree. Also, remove limbs over the house that can transmit fire or fall on a house during high winds. (See materials from the Hawai'i Wildfire Management Organization ("Ready, Set, Go" and "Firewise Landscaping") in the resources section.) Learn how to create a fire free area at least 5 feet around the perimeter of your home. The use of native, high moisture content, drought resistant plants may reduce the ignition potential (see below).



The Hawai'i Wildfire Management Organization has a list of native drought and fire-resistant plants and trees that can help reduce ignition and fire spread. On the list and common at the hardware stores are Ihi, Mamaki, Koki'o and Ohia.

Roofing is Key - The roof is one of the most important parts of a house that determines its resilience. The roof should be fire resistant, resist uplift forces from high winds, sealed to prevent leaks, and reflective to keep the house cool. According to the FEMA Mitigation Assessment Team Report for the Marshall Fire, Class A fire resistant materials are effective against severe fire exposures, provide a high degree of fire protection to the roof deck, and do not present a flying hazard. Class A materials include clay and concrete tiles, metal roofing, brick or masonry, exposed concrete, and most modern asphalt fiberglass composition shingles. Metal and concrete roofs are more expensive than asphalt shingle roofs, so asphalt shingles may be the most common choice for Hawai'i residents. If so, the shingles should be Class A fire rated under ASTM E108 or UL 790. Consider designing the roof as a Class A assembly where all aspects of the roof structure (deck, underlayment, etc.) meet the fire-resistant requirements for the assembly.

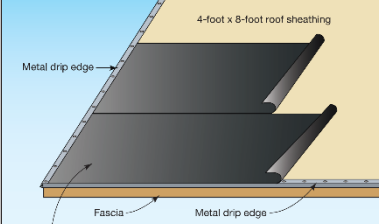
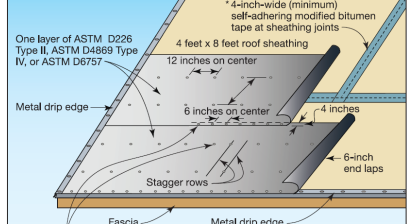
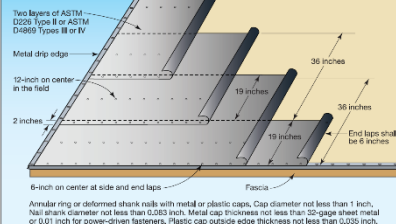
In the figure to the right, different roofing materials, some from Lahaina, were subject to simple fire tests. The wood shake roofing material began to burn, while the Class A fire rated shingle was not singed. If asphalt shingles are used as roofing material, they should also be wind rated to protect against hurricane winds. Look for Class H ASTM D7158 wind resistance. All connectors, flashing and fasteners should be corrosion resistant. Consider additional connectors for wind resistance as detailed in the Homebuilder's Guide to Coastal Construction (FEMA P-499). Materials degrade over time and this degradation is increased in the hot moist environment of Hawai'i. It is imperative to understand the life of the roof and replace any materials that exceed their product life.



To reduce the temperature of the roof, consider high solar reflectivity, thermal emittance and solar reflectance. High solar reflectivity are typically lighter color roofs. The higher the numbers the cooler the roof.

Finally, seal the roof from leaks using the methods shown in the Hombuilder’s Guide (FEMA P-499 – Technical Fact Sheet 7.2). This can be with a self-adhering modified bitumen layer or self-adhering bitumen tape along roof deck joints.

Options to Seal the Roof

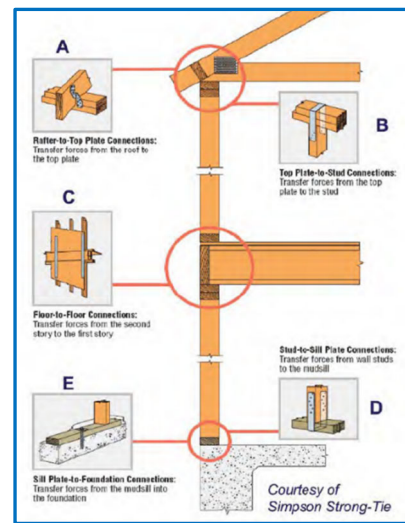
<p>Option 1 – Uses a self-adhering modified bitumen membrane (peel & stick) complying with ASTM D 1970. This is followed by a single layer ASTM D 226 Type 1 (#15) or ASTM D 4869 Type II felt.</p>	<p>Option 2 – Uses 4” wide self- adhering modified bitumen tape along panel seams followed by #30 felt or equivalent.</p>	<p>Option 3 – Uses two layers of #30 felt.</p>
 <p>4-foot x 8-foot roof sheathing</p> <p>Metal drip edge</p> <p>Fascia</p> <p>Metal drip edge</p> <p>*Self-adhering polymer modified bitumen membrane complying with ASTM D1970 applied over the entire roof. All laps to be in accordance with the manufacturer's installation instructions.</p> <p>*Self-Adhering Polymer Modified Bitumen Membranes: Some oriented strand board (OSB) structural panels have a factory-applied coating that can interfere with the bonding of the self-adhering modified bitumen. To facilitate bonding, a field-applied primer is often needed. If self-adhering modified bitumen is applied to OSB, the OSB manufacturer should be contacted to determine whether a primer needs to be applied.</p>	 <p>4-foot x 8 feet roof sheathing</p> <p>12 inches on center</p> <p>6 inches on center</p> <p>4 inches</p> <p>6-inch end laps</p> <p>Stagger rows</p> <p>Fascia</p> <p>Metal drip edge</p> <p>Annular ring or deformed shank nails with metal or plastic caps. Cap diameter not less than 1 inch. Nail shank diameter not less than 0.083 inch. Metal cap thickness not less than 32-gage sheet metal or 0.01 inch for power-driven fasteners. Plastic cap outside edge thickness not less than 0.035 inch.</p>	 <p>Two layers of ASTM D226 Type II or ASTM D4869 Types II or IV</p> <p>Metal drip edge</p> <p>12-inch on center in the field</p> <p>2 inches</p> <p>6-inch on center at side and end laps</p> <p>Fascia</p> <p>End laps shall be 6 inches</p> <p>Annular ring or deformed shank nails with metal or plastic caps. Cap diameter not less than 1 inch. Nail shank diameter not less than 0.083 inch. Metal cap thickness not less than 32-gage sheet metal or 0.01 inch for power-driven fasteners. Plastic cap outside edge thickness not less than 0.035 inch.</p>
<p>Estimated Cost per NAHB 2020 – for 2,900 square foot roof – costs may vary per region & may be higher after a hurricane considering surge demand.</p>		
<p>Self adhered - \$3,600-\$4,000 - #30 felt - \$650-780</p>	<p>Taped sheathing seams + 30# felt: \$2,050-2,430. Synthetic equivalent - \$810 to \$940</p>	<p>#30 felt – For one layer - \$650-780</p>

Please Note the Following:

- 1) All roof designs should consider the design wind loads for Hawaii per the state building code.
- 2) A sealed roof deck should be installed by a professional roofing contractor. Check licensing and background.
- 3) Before sealing the roof deck, check damaged wood sheathing and replace. Ring shank nails provide stronger fastening of sheathing to trusses.
- 4) Install drip edges at eaves/rakes, and proper flashing at roof penetrations and roof/wall intersections.
- 5) Ridge, soffit, and gable vents must be properly secured and flashed.
- 6) For option 2 – Used 30# felt instead of 15#, which is stronger and recommended by IBHS. Drip edges above underlayment provide improved wind performance.
- 7) For option 2, a synthetic equivalent can be used. Check product specifications as it should indicate if the product is manufactured to meet certain ASTM standards. For example, it may say “Physical Requirements of both ASTM D226 and D4869” or “Meets ASTM D6757, inorganic shingle underlayment standard.”
- 8) A sealed roof-deck is not required for most building codes but may require enhanced underlayment. However, a sealed roof-deck is recommended in hurricane-prone regions.

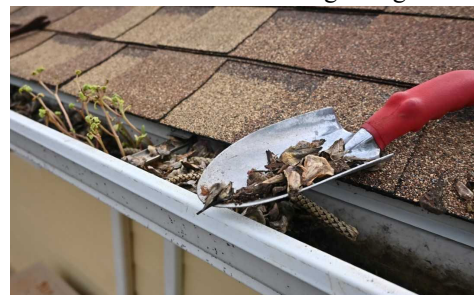
Create a Continuous Load Path Connection - A continuous load path connection ties your roof to the foundation so that it does not blow off. Each intersection of the house – (A) roof to wall, (B) top plate to stud, (C) second floor to first floor, (D) stud to sill plate, and (E) sill plate to the foundation has a specific connection that transfers hurricane wind loads to the ground and keeps your roof in place. The complete load path was generally required on Kaua’i after 1993, on O’ahu and Maui after 1995, and in Hawai’i County after 1994. This was in response to building code changes after Hurricane Iniki in 1992. Check with your licensed architect or engineer to confirm the status of your house.

All new houses should have a complete load path to protect the house from hurricane winds. In addition, roofing material should be properly fastened to the roof deck and the roof deck to the trusses. See: Building for High-Wind Resilience in Light-Frame Wood Construction by APA, the Homeowner’s Handbook to Prepare for Natural Hazards – 4th Edition by the University of Hawai’i Sea Grant College Program (Hawai’i Sea Grant) and Retrofit Solutions for Hawai’i Homeowner’s by Simpson Strong-Tie. For existing houses, it is not easy to retrofit to add the continuous load path due to limited



access. However, it is suggested that for older houses, the roof to wall connection be addressed as it is a relatively easy retrofit for the weakest part of the house. Generally, the roof to wall connection was required on O‘ahu after 1988, on Kaua‘i and Maui after 1990, and in Hawai‘i County after 1994. Before these dates, there was likely no roof to wall tie. Again, check with a licensed professional (architect and engineer) and if absent, follow the tips in Homeowner’s Handbook and Retrofit Solutions to Hawai‘i publications.

Protect the Envelope of the House - With a strong framing of the house, the envelope needs to be fire resistant and detailed properly to prevent intrusion of embers. Good resources to address the outer envelope are the FEMA Marshall Fire Mitigation Assessment Team report (MAT) & Technical Advisories and the publication Ready, Set, Go! from the Hawai‘i Wildfire Management Organization (links are provided at the end of this section). According to the FEMA MAT report, brick, stone, stucco, and fiber cement board performed well during the Marshall Fire. Products that are not fire resistant include vinyl, which can melt, or combustible materials such as wood, boards, or panels. It is important to consider the full wall assembly when designing the structure and at a minimum, design the exterior wall to at least a one-hour fire resistance rating. Gutters should be cleared of leaves, debris, or collected vegetation. Once clean, the gutters can be protected from further accumulations with noncombustible gutter guards or screens. Consider designing or replacing vinyl gutters with non-combustible metal gutters. Vents to the attic are a potential entry point for intrusion of fire embers. Metal mesh screens should provide protection with holes at 1/8 inch or smaller. Windows can break from the heat even before the home ignites which will allow embers to enter the building. Dual-paned windows with an exterior pane of tempered glass can reduce the chance of breakage. Impact resistant windows can provide protection from heat and hurricane wind-borne debris because they consist of two panes of tempered glass and a vinyl interlayer. Impact resistant windows may be required in some areas of Hawaii where high winds are probable. While impact resistant windows are not typically tested for fire exposure, the design may reduce breakage from heat. For impact resistant windows, leave on any stickers that indicate the glass is impact resistant as this may change how firefighters interact with the structure. Jalousie windows should be replaced with double paned traditional windows. Where jalousie windows are present, they should remain in the closed position during red flag days when the risk of wildfire is the highest.

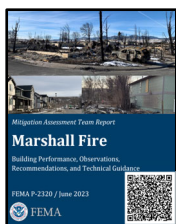


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Marshall Fire Mitigation Assessment Team report (MAT) & Technical Advisories

The [MAT report and 6 technical advisories](#) compiled lessons learned from the 2021 Marshall Fire in Boulder County, Colorado to reduce losses from wildfire, covering topics including:

- Defensible space in low- and high-density communities
- Best practices for wildfire-resilient subdivision planning
- Decreasing risk of structure-to-structure fire spread
- Wildfire-resilient detailing, joint systems, and interfaces of building components
- Mitigation strategies to address multi-hazard events



Ready, Set, Go!

The [Hawai‘i wildfire readiness guide](#) explains:

- The conditions that contribute to wildfire
- Readiness strategies for homeowners in Hawai‘i, including:
 - Wildfire-resilient retrofits
 - Defensible space
 - Creating your own wildfire emergency action plan
 - Residential safety checklist



Tips for Firewise Landscaping

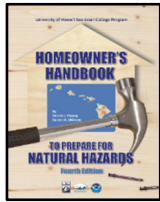


This [brochure](#) provides guidance on selecting suitable plants for your yard to reduce wildfire hazards. The tips for landscaping contain guidance for plant:

- Selection
- Placement
- Care

It also includes references to weeds that should be avoided for their fire-promoting traits, and tools to assist in the selection of non-invasive trees and plants.

Homeowner's Handbook to Prepare for Natural Hazards – Fourth Edition



The [Homeowner's Handbook](#) from Hawai'i Sea Grant covers:

- Science of drought, wildfires, hurricanes, tsunamis, other hazards
- Emergency supplies and evacuation kit
- Emergency/evacuation plans (flood, wildfire, tsunami, hurricane)
- Defensible space & fire mitigation
- Continuous load path
- Wind resistant retrofits step-by-step guide (roof to wall ties, windows)
- Creating strong, cool, sealed roof

Retrofit Solutions for Hawai'i Homeowners – Simpson Strong-Tie



This [brochure](#) covers:

- Roof to wall ties
- HPTZ hurricane tie – specifically for older Hawaiian Homes
- Opening protection
- Post-and-pier retrofit

Building for High-Wind Resilience in Light-Frame Wood Construction



This [APA Brochure](#) is useful for existing older houses in Hawai'i with light-wood frame construction. Although concrete-CMU construction would be more fire resistant, there are still many wood frame houses in existence. It is still possible to make wood structures more fire resilient with defensible space and fire-resistant materials that are properly detailed for the house envelope.

- Continuous-load-path
- Roof to wall ties
- Attaching decking to trusses

Additional Resources

Community, Businesses, and Homeowners

- [Building Codes – County of Maui](#): The Development Services Administration provides an overview of the building codes enforced by the County of Maui, including the county and/or state amendments.
 - [2024 International Wildland Urban Interface Code](#): Optional building code with provisions that help protect life and property from wildland fires, adjacent structure fires, and fires spreading through wildland fuels.
 - [2020 ICC 700 National Green Building Standard](#): Optional building code that offers design flexibility for sustainable and cost-effective approaches for topics such as resource, water, and energy efficiency.
- [Business Check – Contractor Licensing](#): Search tools to find a licensed contractor.
- [Disaster Recovery Building Permit](#): Instructions on applying for a permit to repair, rebuild, or alter a structure damaged by qualifying disaster events.
- [Fire Hazard Mitigation Methodology](#): Provides technical knowledge on combining property and community-level Wildland Urban Interface mitigation strategies, including defensible space, structural hardening, housing density, structure separation distance and property layouts.
- [Get Support at Resource Centers](#): Comprehensive resource list for local in-person survivor support.
- [Hawai'i wildfires | U.S. Small Business Administration](#): Guidance on applying for Small Business Administration Disaster Loans for homeowners, renters, small businesses, and nonprofits.

- [Insurance | Fire Claim Information](#): Guidance and commonly asked questions on filing an insurance claim for property damaged by wildfires.
- [Maui Fires Recovery - AIA](#): This guide developed by the American Institute of Architects shares links to architects in Maui, Hawai'i and abroad to assist in recovery. It also offers links to helpful websites and resource documents.
- [Maui Recovers](#): Offers community news updates associated with the recovery and several support resources for residents and businesses with opportunities to obtain in-person assistance for fire recovery.
- [Maui Recovery Assistance](#): This resource hub offers assistance for housing, financial relief, employment, business, food, medical, and transportation.
- [Outdoor Fire Safety](#): Safety tips to keep residents fire safe while enjoying outside activities including messages on grill fire safety, fire pits, campfires, chimney and outdoor fireplaces, and fireworks.
- [Pacific Fire Exchange](#): Program that shares fire science and research for practitioners, scientists, policymakers, and communities within the U.S.-affiliated Pacific Islands.
- [WUI Virtual Handbook](#): Provides resource materials and fire mitigation strategies to fire departments for property risk assessments in the Wildland-Urban Interface.

Community Specific – Wildfire Protection Plans

Provides a map of communities at risk from wildfires, guidance for hazardous fuel reduction treatments, and reducing structural ignitability.

- [South Maui - Community Wildfire Protection Plan](#):
- [Western Maui – Community Wildfire Protection Plan](#):
- [Upcountry Maui – Community Wildfire Protection Plan](#)

Home Specific

- [Home Builders Guide to Construction in Wildfire Zone](#): Recommendations for building design and construction methods consolidated into 17 fact sheets to increase the chance of building survival in wildfire zones.
- [Home Disaster Guides](#): Guidance for making your home more prepared for wildfires, hurricanes, and thunderstorms with wildfire information associated with critical home preparations, exterior home upgrades, wildfire-resistant yards, and home evacuation steps.
- [Rebuild — Helping Maui](#): A step-by-step guide to the rebuilding process for Maui homeowners.
- [Retrofitting a Home for Wildfire Resistance – Cost Considerations](#): Summarizes the costs and benefits of retrofitting a home for wildfire resistance. The study is based in California, but it can be referenced as a benchmark for affordability and benefits.
- [Wildfire Home Retrofit Guide](#): Specific retrofit recommendations to help homes survive wildfires.
- [Wildfire Home Risk Assessment](#): Volunteer home assessors may be available to perform a free review of a home and yard for wildfire and ember ignition.
- [Wildfire Prepared](#): Preventative measures to protect a home and yard against wildfire with steps to achieve a three-year designation certificate.