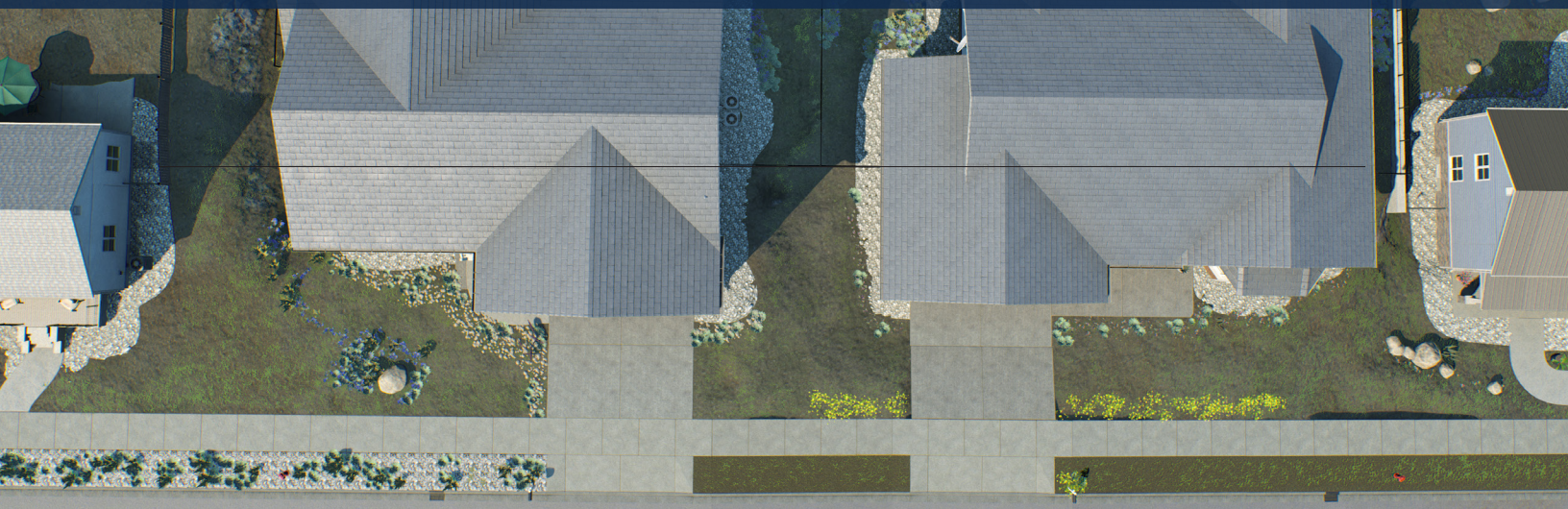
IBHS RESEARCH

NONCOMBUSTIBLE ZONE 0:

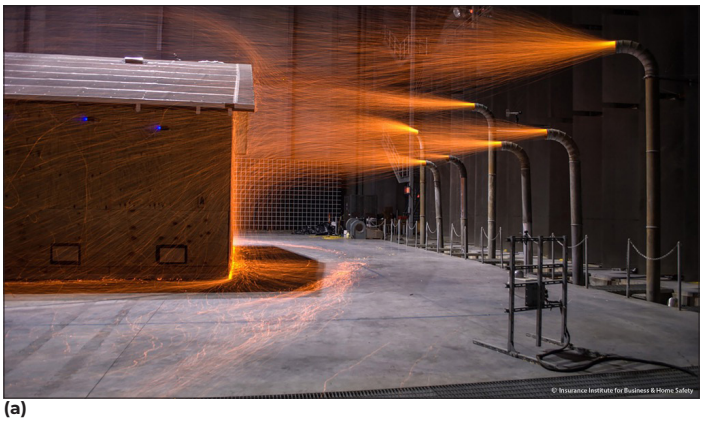
MINIMIZING PATHWAYS TO HOME IGNITION



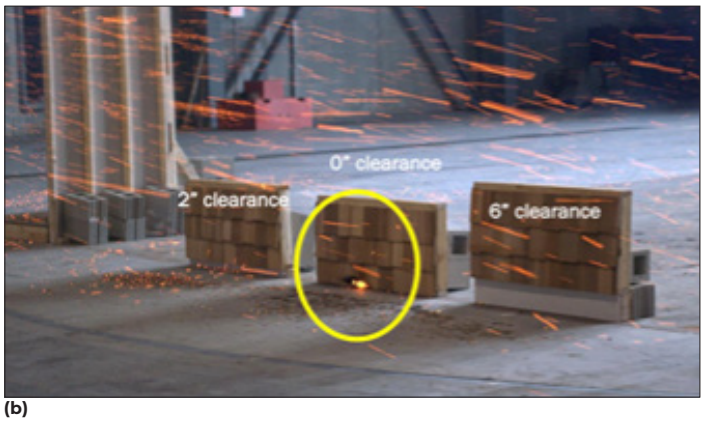
Noncombustible Zone 0: Minimizing Pathways to Home Ignition

Wildfire science has sufficiently advanced such that researchers can now identify key parcel-level mitigation actions homeowners can take to meaningfully reduce the risk of home ignition from wildfires. Among these advances, a critical finding is the importance of defensible space in the 5-foot area immediately surrounding structures—sometimes called "Zone 0," the "ember-resistant zone," or the "home ignition zone." However named, this area has emerged as a significant vector for home ignitions by wildfire, as it is the place in which the embers, flames, and radiant heat associated with wildfire reach the home.

Laboratory experiments and post-disaster investigations concerning Zone 0 instruct a simple and effective lesson: removing combustible material from Zone 0 minimizes pathways for wildfires to ignite homes. Embers that land in a combustible-free Zone 0 do not have available material to ignite. Flames that reach a combustible-free Zone 0 do not have fuels to complete the pathway to the home. And a radiant heat source, such as a burning shrub or dog house, that maintains a distance of at least 5 feet from a home lessens the likelihood of ignition. As homeowners, homeowners associations, community groups, and state policymakers consider investments, requirements, regulations, and laws addressing wildfire mitigation and defensible space requirements, **a fully noncombustible Zone 0 is the most effective defensible space mitigation to reduce home ignition from wildfire.**



(a)



(b)

Figure 1. Ember accumulation at the base of the wall and causing ignition (a and b) at the IBHS Research Center.

The Importance of Zone 0

Wildfire research has long underscored the importance of fuel treatment and management near buildings (i.e., the creation and maintenance of "defensible space") to minimize the likelihood of flame contact and extended radiant heat exposure to reduce wildfire risk. This research has been undertaken experimentally[1] and in post-event investigations.[2] In particular, vegetation near homes is a substantial vulnerability.[3]

Notwithstanding some support for near-home noncombustible zones,[4] defensible space has traditionally been split in two zones: (i) 0–30 feet and (ii) 30–100 feet or to the property line. Today, there is growing acceptance for a need to specifically address defensible space in the area closest to structures and differentiate it from the other zones. A specialized defensible zone in the 5 feet closest to structures is **essential because ember ignitions of combustible materials near the building create a critical threat from potential small flames,** which shift the dominant heat transfer mechanism from radiation to direct flame contact. Experiments at IBHS's Research Center demonstrate that embers accumulate at the base of buildings and within the first 5 feet during ember storm conditions with realistic wind flows (see Figure 1).

[1] Jack D Cohen, "Relating flame radiation to home ignition using modeling and experimental crown fires," *Canadian Journal of Forest Research* 34, no. 8 (2004); Jack D Cohen, "Preventing disaster: home ignitability in the wildland-urban interface," *Journal of Forestry* 98, no. 3 (2000).

[2] Alexander Maranghides et al., *A case study of a community affected by the Witch and Guejito Fires: Report# 2: Evaluating the effects of hazard mitigation actions on structure ignitions*, National Institute of Standards and Technology, (National Institute of Standards and Technology, 2013); Xiaoyang Zhang et al., "The footprint of urban climates on vegetation phenology," *Geophysical Research Letters* 31, no. 12 (2004).

[3] Raquel SP Hakes et al., "A review of pathways for building fire spread in the wildland urban interface part II: response of components and systems and mitigation strategies in the United States," *Fire Technology* 53, no. 2 (2017).

[4] E Smith and G Adams, "Incline village/crystal bay defensible space handbook [SP-91-061]," (Reno, NV: University of Nevada Cooperative Extension Publication, 1991); Faraz Hedayati et al., *Near-Building Noncombustible Zone*, Insurance Institute for Business & Home Safety (2018), https://ibhs.org/wp-content/uploads/member_docs/Near-Building_Noncombustible_Zone_Report_IBHS.pdf.

Zone 0: Example of a house employing a noncombustible 5-foot area immediately surrounding the home.

Accumulation of embers in the vicinity of obstacles is also reported by others.[5] These findings suggest that combustibles in Zone 0 function as ember collectors and act as a potential ignition source. Thus, clearing this area of all combustible materials—vegetative and nonvegetative—plays an important role in reducing the likelihood of home ignition.

The Effect of Combustibles in Zone 0

Analyzing over 2000 structures in San Diego County, Syphard et al. concluded that **structures were more likely to survive a fire with an effective defensible space "immediately adjacent" to them.**[6] Syphard et al. also report that reducing woody vegetation cover up to 40% immediately adjacent to structures and preventing vegetation from overhanging or touching structures were the most effective actions to reduce risk of home ignition.

Using a statistical analysis of data from 27 independent forest fires in New South Wales, Australia, Penman et al. concluded that vegetation touching houses likely caused ignition of the house once the vegetation ignited.[7] Research that explored heat exposure on wall cladding materials concluded that ignition potential is significantly lower from sources outside of Zone 0 as compared to sources within 5 feet.[8] An analysis of aerial imagery and insurance claims data concluded that light vegetation density in Zone 0 lowers the likelihood of destruction. The probability of a total loss was about 2 times lower relative to buildings with high density vegetation in Zone 0, noting "having heavy vegetation, more than 50% coverage, (including brush, trees, and shrubs) immediately around the home can nearly double the chance of destruction."[9]

Post-wildfire investigations support both experimental and computational research in that the elimination of combustible material from Zone 0 is a necessary mitigation action to reduce

[5] Sayaka Suzuki and Samuel L Manzello, "Experimental investigation of firebrand accumulation zones in front of obstacles," *Fire Safety Journal* 94 (2017).

[6] Alexandra D Syphard, Teresa J Brennan, and Jon E Keeley, "The role of defensible space for residential structure protection during wildfires," *International Journal of Wildland Fire* 23, no. 8 (2014).

[7] Heather Anu Kramer et al., "High wildfire damage in interface communities in California," *International Journal of Wildland Fire* 28, no. 9 (2019).

[8] Hedayati et al., *Near-Building Noncombustible Zone*; Philip Gibbons et al., "Land management practices associated with house loss in wildfires," PloS one 7, no. 1 (2012).

[9] Ellie Arrowsmith, Frederick Dube Fortier, and Anne D. Cope, *Wildfire Fuel Management & Risk Mitigation, Zesty*.ai (2021).

(2a)

Figure 2. Example of vegetation in small amounts located in Zone 0 creating a pathway for fire spread: (a) tree branches overhanging Zone 0 burn during the Camp Fire (2018) in Butte County, California, and provide a pathway for fire to reach a home[Figure 53 in NIST Technical Note 2135 https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2135.pdf] (used with permission) and (b) ground-level plants during the Glass Fire 2020 in Napa and Sonoma Counties, California. This house was likely defended by first responders during the event.

the risk of home ignitions. The investigation performed after the Grass Valley Fire in 2008 concluded that **home ignitions were caused by embers igniting buildings or creating spot fires in the immediate areas around the building rather than high intensity flames.**[10] The National Institute of Standards and Technology's post-Camp Fire report likewise concludes that overhanging trees within Zone 0 could have provided fuel pathways that led to home ignitions.[11] This work also provided examples where overhanging trees within the 0–5 foot zone could also ignite the building. The IBHS post-Glass Fire investigation also observed vegetation that likely provided a pathway for ignition when plants—even in small amounts—touch the building as shown in Figure 2b. The house in Figure 2b was likely defended by first responders during the event.

(2b)

[10] Jack D Cohen and Richard D Stratton, "Home destruction examination: Grass Valley Fire, Lake Arrowhead, California," *Tech. Paper R5-TP-026b. Vallejo, CA: US Department of Agriculture, Forest Service, Pacific Southwest Region (Region 5).* 26 p. (2008).

[11] Alexander Maranghides et al., *A Case Study of the Camp Fire–Fire Progression Timeline Appendix C. Community WUI Fire Hazard Evaluation Framework* (National Institute of Standards and Technology, 2021).

[12] Karina Meerpoel-Pietri, Virginie Tihay-Felicelli, and Paul-Antoine Santoni, "Determination of the critical conditions leading to the ignition of decking slabs by flaming firebrands," *Fire Safety Journal* 120 (2021); Hakes et al., "A review of pathways for building fire spread in the wildland urban interface part II: response of components and systems and mitigation strategies in the United States."; Faraz Hedayati, Stephen L Quarles, and Christine Standohar-Alfano, "Evaluating Deck Fire Performance—Limitations of the Test Methods Currently Used in California's Building Codes," *Fire 5*, no. 4 (2022).

(a)

(b)

(c)

(d)

Figure 3. Examples of combustible fencing providing a pathway for fire to the house, damaging the noncombustible siding and eave (a and b) in the Glass Fire (2020) in Napa and Sonoma Counties, California, defended; (c) in the Camp Fire (2018) in Butte County, California, defended by first responders; and (d) at the IBHS Research Center.

The same sequence of events is applicable to non-vegetative fuels adjacent to a structure. As demonstrated in Figure 3, non-vegetative combustibles—including structural fuels, fences, and attached decks in contact with a building or located within Zone 0—also provide pathways for home ignitions.[12] These findings have been confirmed in post-event investigations.[13]

Conclusion

While scientific understanding of a wildfire's interaction with the built environment continues to develop and advance, sufficient progress has been made to make certain conclusions. Of these conclusions, the centrality of Zone 0 to home ignition reduction is paramount. While additional research will undoubtedly continue to sharpen our understanding of reducing risk in Zone 0, current knowledge indicates that **removing all combustibles from the 5 feet around the home is the most effective way to minimize pathways to home ignition and reduce the risk of wildfire.**

[13] Insurance Institute for Business & Home Safety, *California Wildfires of 2017* and 2018 (2020), https://ibhs.org/wp-content/uploads/member_docs/camp-fire-report_ibhs-1.pdf; Kathryn Butler et al., *Wind-Driven Fire Spread to a Structure from Fences and Mulch* (National Institute of Standards and Technology, 2022).