Home Hardening Techniques

Fire Resistant & Cost Effective

AIA California

LEARNING OBJECTIVES

- Review California's Wildland-Urban Interface (WUI) building codes and relevant updates.
- Study key fire-resistant construction techniques (e.g., ember-resistant vents, non-combustible materials, and tempered glass).
- Explore cost-effective home hardening approaches for homeowners.
- Analyze case studies of fire-resilient structures and low-cost retrofit programs.

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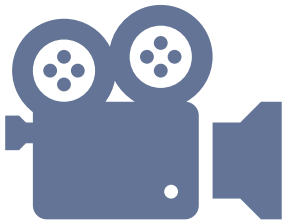
HOUSEKEEPING REMINDERS



Resources will be made available on our website

Qualifies for 1.5 AIA HSW/LU

Q&A

Cultivate a positive learning environment

SPEAKERS

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AIA San Fernando Valley

- Frank L. Frievalt | Director, Wildland-Urban Interface Fire Institute at Cal Poly, San Luis Obispo
- Nate Wittasek, P.E., C.F.E.I., LEED AP | Principal, Simpson Gumpertz & Heger (SGH)
- Cameron Chorney, PE | Associate/ Senior Engineer, RDH Los Angeles
- Greg Kochanowski, AIA, ASLA | Design Principal, Practice & Founder, The Wild: A Research Lab
- Mohamed Sharif, AIA, RIBA | Partner, Sharif, Lynch, Architecture & Director, Undergraduate Program in Architectural Studies and Graduate Program Design Faculty, UCLA Architecture and Urban Design

Fast Fires, The 3-Risks, and Structural Hardening

How Wildfire Attacks Homes, and Consideration of Risk Mitigation Against Structural Ignition

Frank Frievalt, Director
Cal Poly Wildland-Urban Interface FIRE Institute
3/26/25

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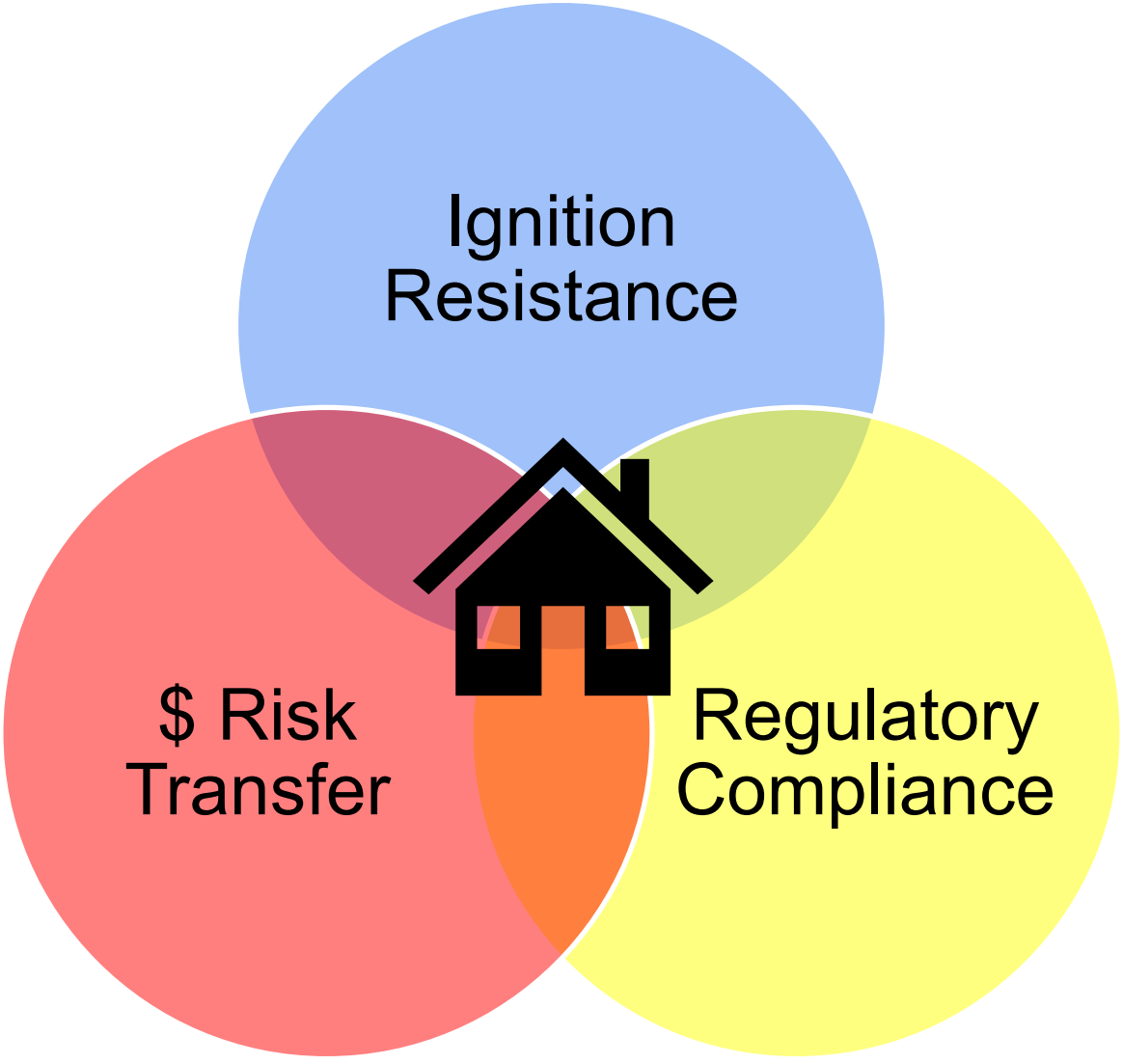
How Wildfire Attacks Homes in the WUI

- “Therefore, we define fast fires as events that grow >1620 ha (roughly 4,000 ac) on a single day (i.e., maximum FGR > 1620 ha/day). These fast fires represent only 2.7% of all events, yet they account for 89% of the total structures damaged or destroyed.”
- “This speed corresponds to the 97th percentile of maximum daily fire growth registered between 2001 and 2020, representing 1616 events out of 60,012 total events and 60.1% of the burned area in the FIRED record.
- Sustained high winds, low RH, close proximity to WUI, following a period of desiccation.

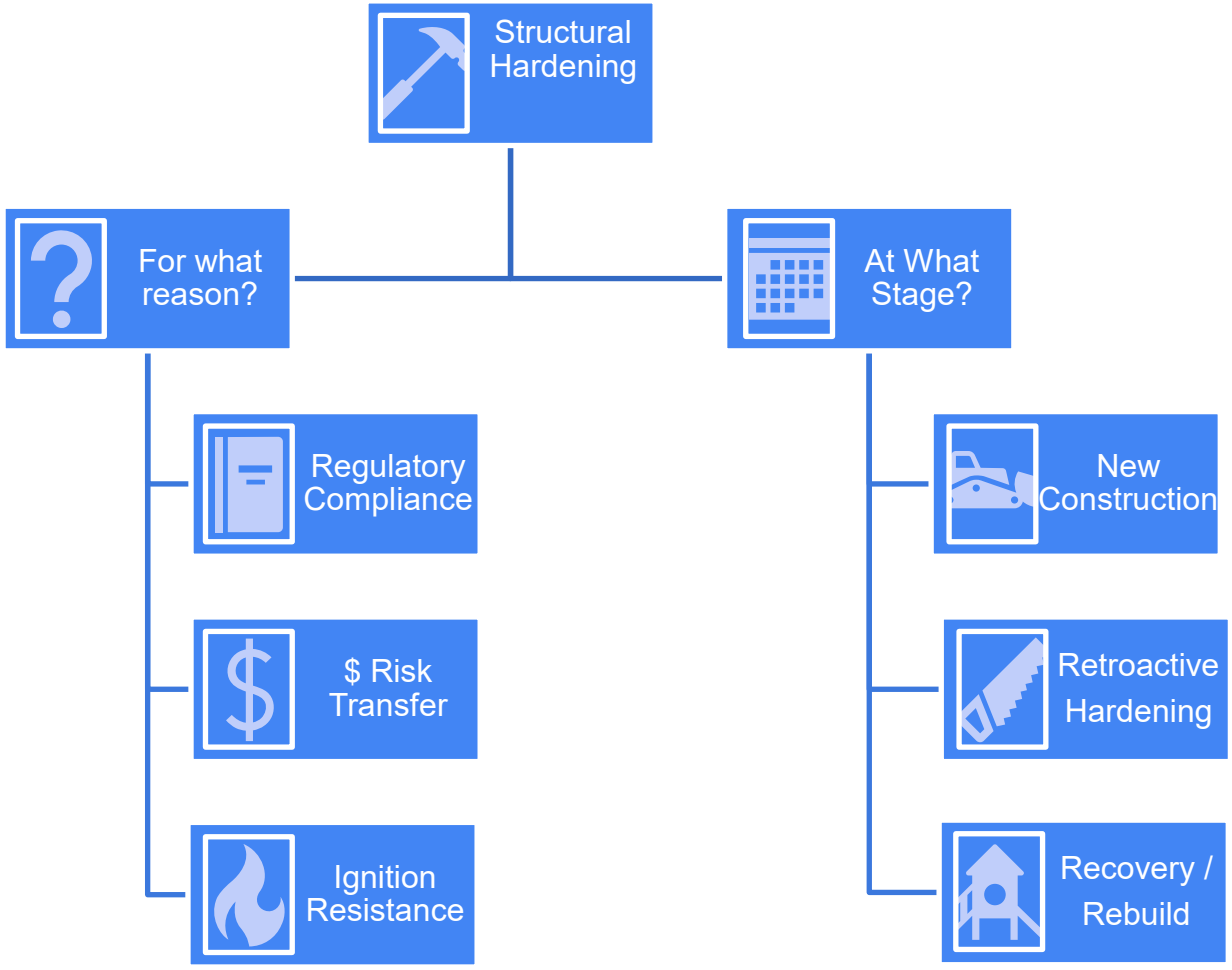
Jennifer K. Balch et al.,
The fastest-growing and most destructive fires in the US (2001 to 2020).Science386,425-431(2024).DOI:10.1126/science.adk5737

Risk = Hazard x Consequence

The 3-"Risks"



The What and When of Structural Hardening



MARCH 26, 2025

Wildfire Resistant Construction - Lessons Learned and Rebuilding

Cameron Chorney | PE
Associate, Senior Engineer
RDH Los Angeles

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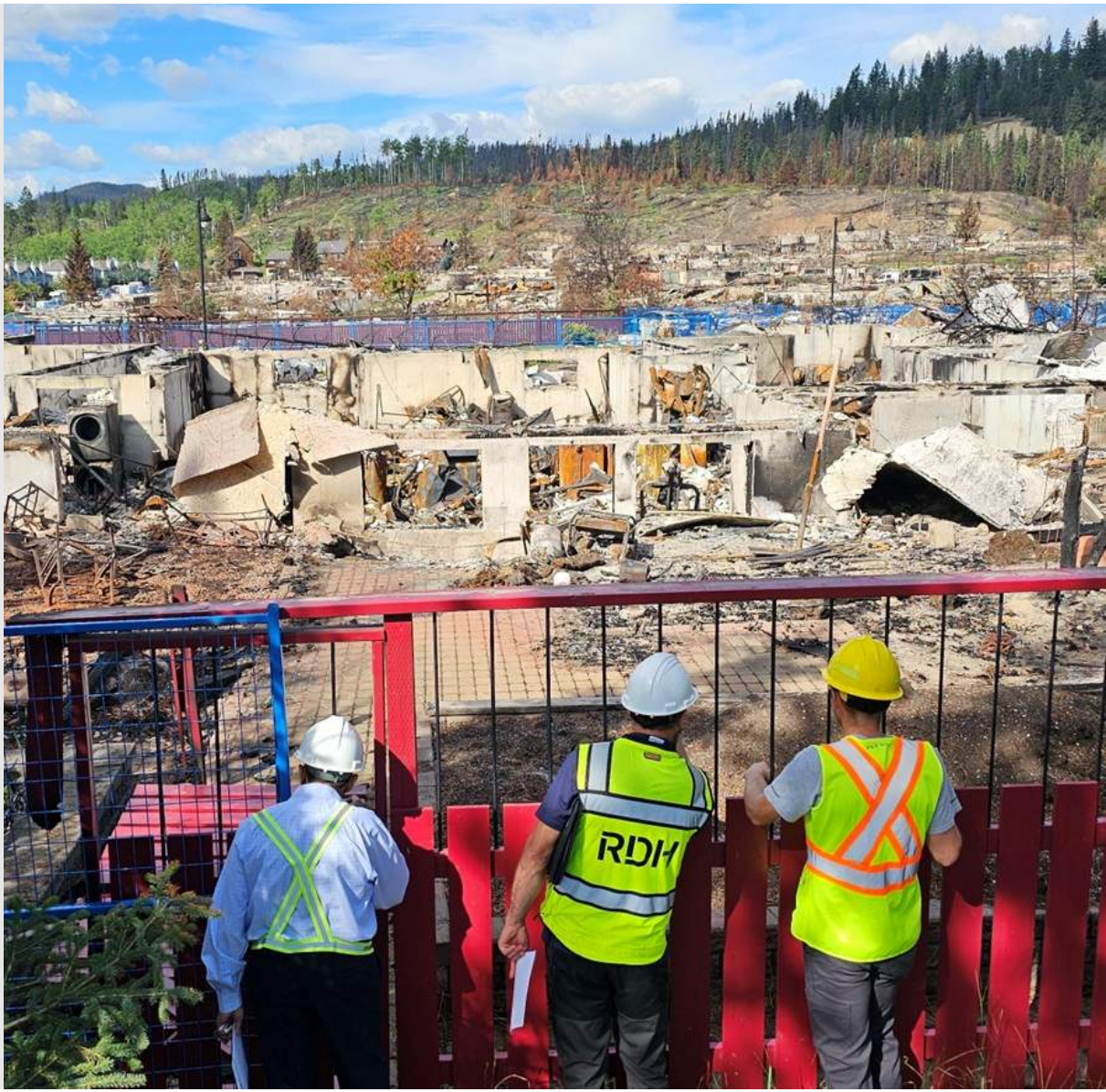
RDH



Disclaimer

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Outline

- Case Studies and Lessons Learned
- How Do I Know If My Project Building Is At Risk?
- What is Wildfire Resistant Construction (WFRC) ?
- Wildfire Resistant Construction Details
- Cost Analysis
- Additional Resources
- Discussion & Questions

Case Studies & Lessons Learned

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Case Study - Lahaina

- 2023 - destroyed town of Lahaina, Maui
- Fast moving grass fire, initially ignited highly susceptible building enclosures (cedar siding/shake roofs, single pane windows)
- Quickly lead to building to building spread (urban conflagration)
- Fire fighting resources quickly overwhelmed
- Some lessons from surviving buildings – more resilient construction, landscaping, location etc.
- Report produced in 2020 stated West Maui had >90% chance of wildfires every year

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Case Study – Camp Fire

- 2018 - destroyed 1800 structures, including Paradise, California
- Dry conditions, fast moving forest fire fueled by strong winds ignited highly susceptible buildings
- Majority damage was building to building spread
- Assessment of damage (pre/post 2008 California wildfire code introduction)
  - 18% of homes built before 2008 survived (no building requirements for wildfire resiliency)
  - 51% of homes built after 2008 survived (improved building enclosure resiliency)
    - Most of the 49% damaged were structure to structure fire damage
- The footprint of the Camp Fire had experienced 13 large wildfires since 1999, 42 since 1914. Significant mitigation taken from 2011 onwards

Camp Fire Lessons

- Wildfire Building Code works
- Existing buildings are an overwhelming proportion of structures in WUI zones
  - 3% of the homes affected by the Camp Fire were built after 2008 (350)
  - 97% built before 2008 (12000)
- Can't just focus on new buildings – Also need to address existing building vulnerabilities for community protection
- Building enclosure weak points need to be addressed
- Forest fire, sparks and embers and then building to building spread
- Voluntary enrollment is insufficient for community resistance

WILDFIRE DEFENSIBLE SPACE AND READINESS CHECKLIST

Homeowner's Self-Assessment

Paradise FireSafe COUNCIL

		Y	N
A.	***Property Access***		
1.	Mailbox and/or house are clearly marked with street address using 3" high reflective numbers and letters.		
2.	Driveway is at least 12 ft. wide with 15 ft. vertical clearance for emergency vehicles, and is free of obstructions.		
3.	If there is a gate, it is 2 ft. wider than the drive, opens inward, and has a key/code box if normally kept locked.		
4.	Fire engine can turn around on property or in the street.		
B.	***Landscaping and Vegetation***		
1.	All dry grass, needles and leaves are kept cleared at least a distance of 10 ft. from any structure.		
2.	From all structures the majority of native brush is cut and removed for a distance of one hundred (100) ft, or the property line as the terrain allows.		
3.	Some native brush may remain, provided the nearest branches of individual or small grouping of plants are at least 10 ft. apart.		
4.	The canopy of trees within the 100 ft. of defensible space, are raised 10 ft. from the ground or 1/3 of the tree.		
5.	Remove any portion of a tree that is dead and extends over a structure.		
C.	***Structure(s)***		
1.	Roof is constructed of fire resistive material, and is kept free of accumulations of leaves and pine needles.		
2.	Siding is constructed of fire resistive material.		
3.	Structures constructed of wood siding are well painted with quality latex paint.		
4.	Windows are dual pane with energy efficient glass to reflect heat.		
5.	Eaves are enclosed with a fire resistive material.		
6.	Attic vents and chimneys are screened (maximum 1/8 "screen) or otherwise protected.		
7.	Gutters are covered and/or clear of pine needles, leaves and any other debris.		
8.	Decks are enclosed or protected with fire resistant material and kept clear of flammable materials.		
9.	Remove that portion of any tree that extends within 10 ft. of any stovepipe or chimney.		
10.	Compost and wood piles are kept a minimum of 30 ft. from any structure		
D.	***Liquid Propane Tanks***		
1.	Immediately around and under the tank provide total clearance to the soil for a distance of not less than 5 ft.		
2.	The remaining distance shall be maintained, grass is cut to three inches in height for a distance of 10 ft.		
3.	All other flammable vegetative growth or combustible debris should be removed for at least 10 ft, so it is not over-hanging or covering the tank.		
E.	***Miscellaneous Items (Personal and Family Readiness)***		
1.	Hydrant or other water supply is nearby, marked and available.		
2.	An emergency generator is available.		
3.	Know how to shut off gas at meter or propane tank.		
3.	Own an Emergency Scanner and/or access the Town of Paradise Highway Advisory System, 1500 AM radio.		
4.	Outbuildings are equipped with accessible rakes, shovels, ladders, water buckets and hose.		
5.	Know the community evacuation plan; prepare and practice an individual/family plan.		

This checklist is provided to you as a tool to evaluate your Wildfire defensible space readiness. For questions and clarifications contact the local Fire Departments or Fire Safe Councils.

Paradise Fire Safe Council (530) 872-6264
On the Web: buttefiresafe.org/paradisefsc.php
CAL FIRE Butte County (530) 538-7888

paradisefirecouncil@yahoo.com
Paradise Fire Department (530) 872-6264
Butte County Fire Safe Council (530) 877-0984

July 5, 2008

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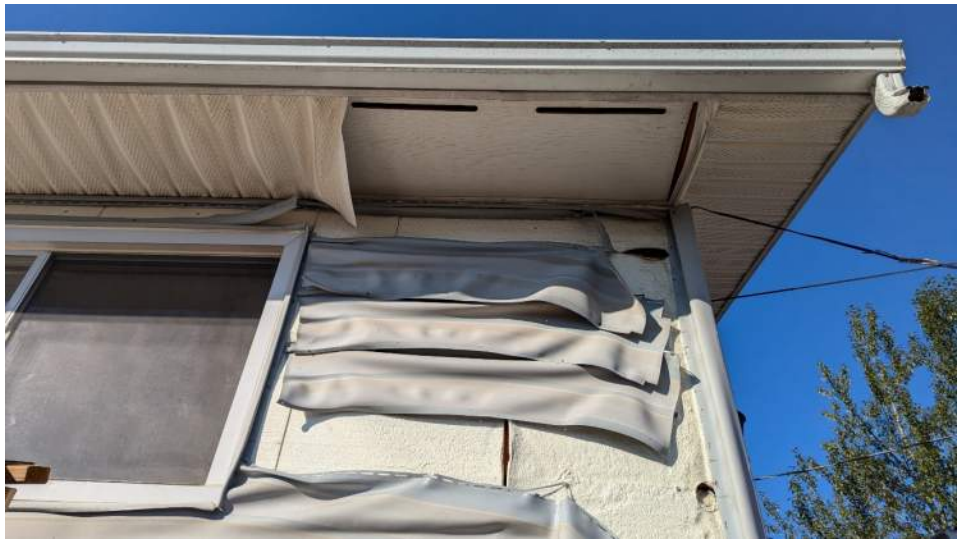
Exterior Wall Assemblies



Roofing Assemblies

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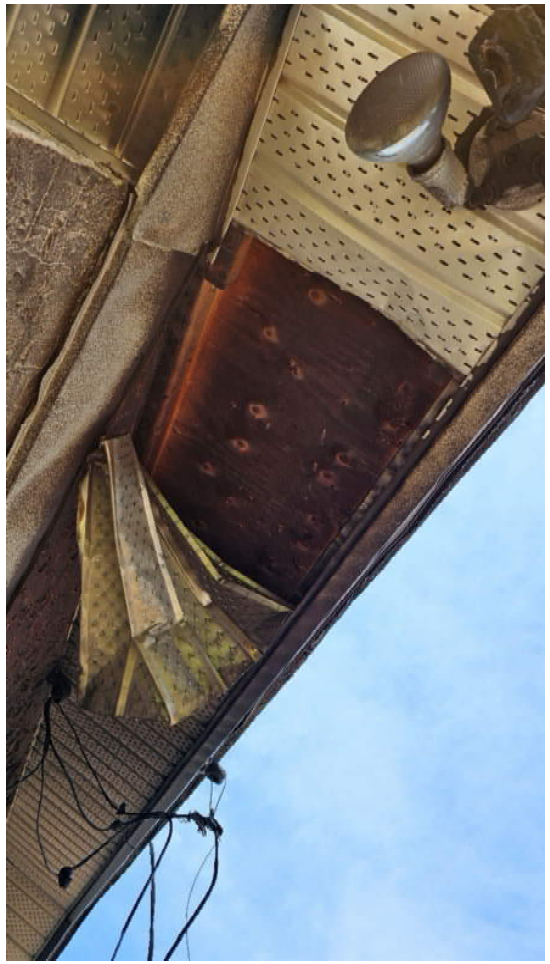
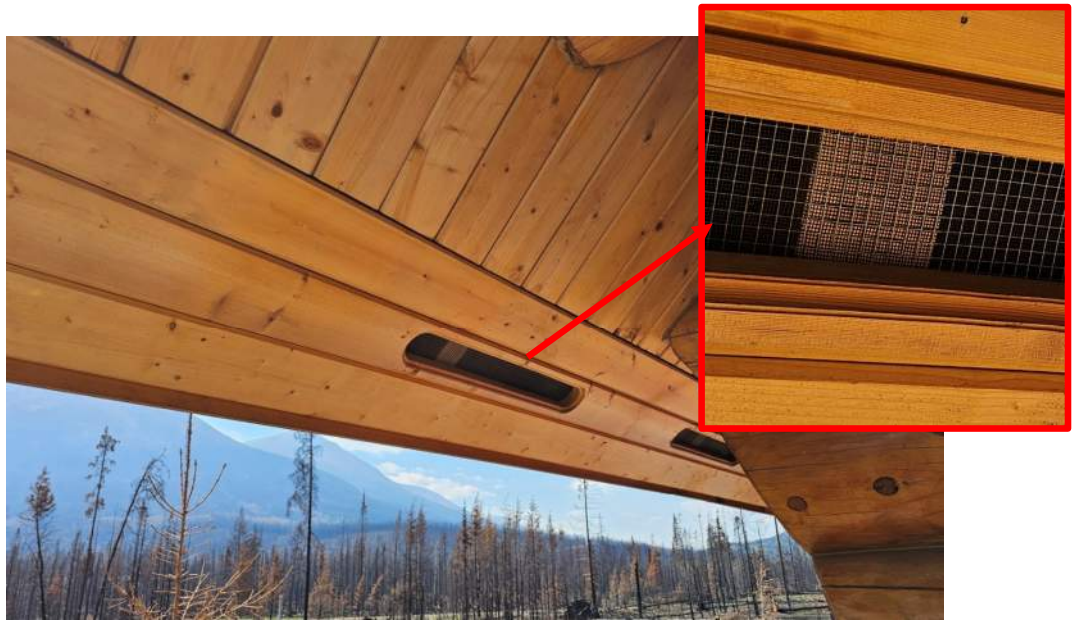
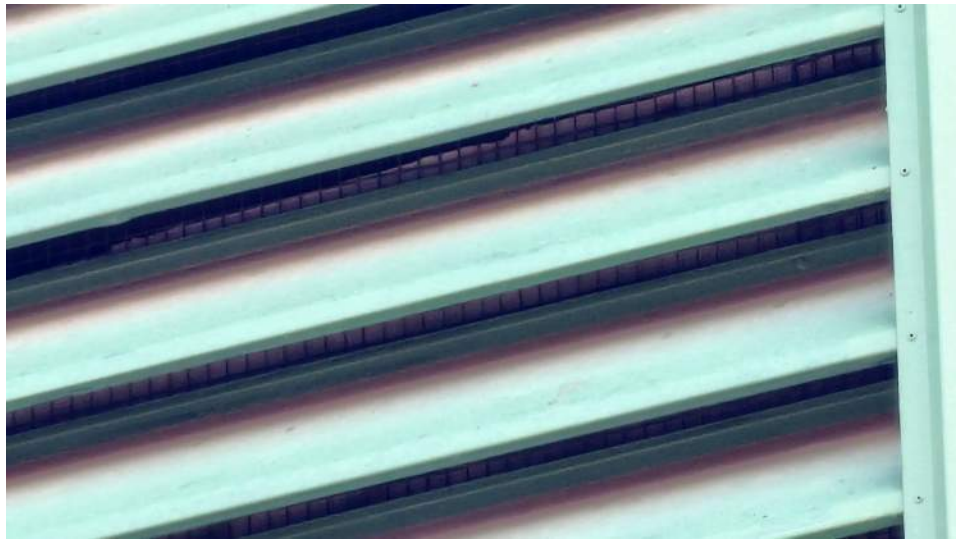
Wood Decks, Fencing & Other Fuel

Soffits & Vents







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Window Assemblies

Concrete Foundations

Metal Buildings

Sprinklers & Active Fire Protection

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How Do I Know If My Project Building Is At Risk?

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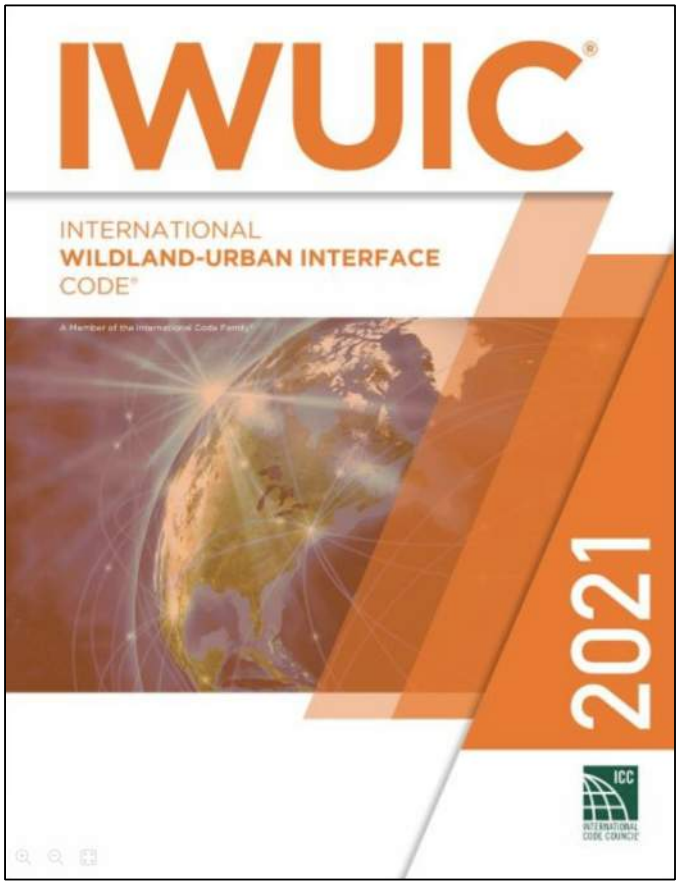
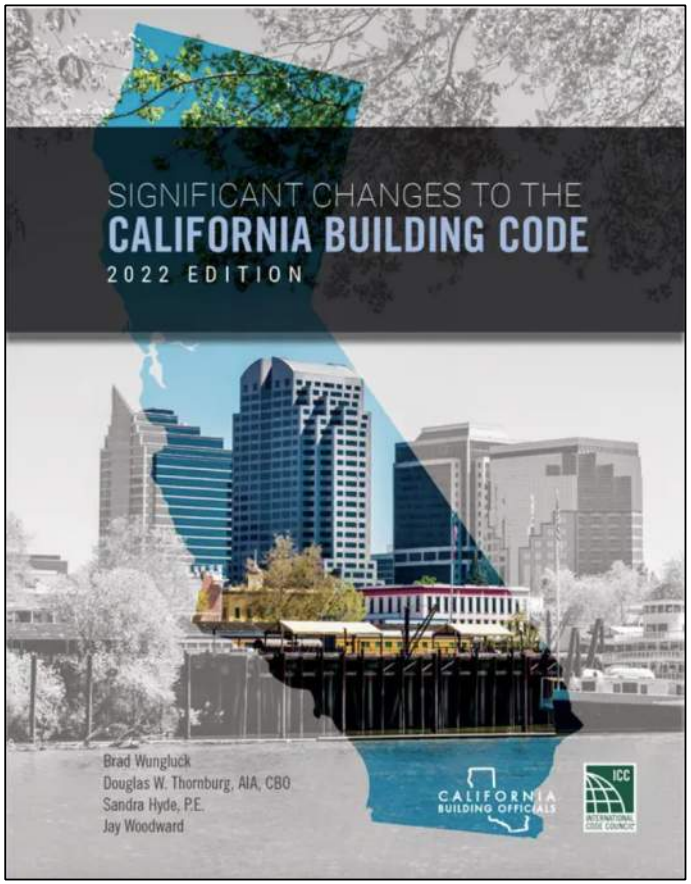
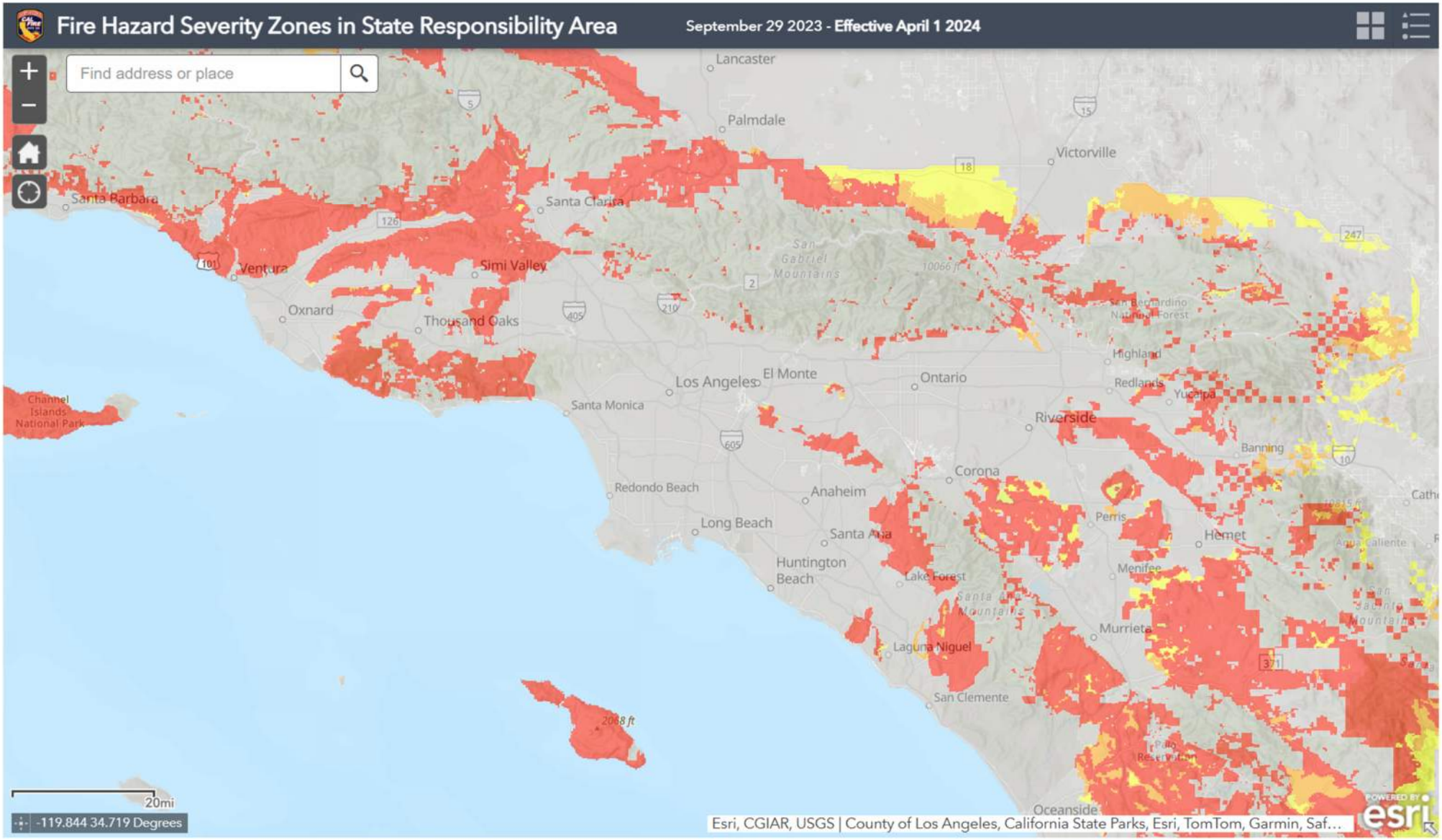




- Chapter 7A *[SFM] Materials and Construction Methods for Exterior Wildfire Exposure*
  - 701A *Scope, Purpose and Application*
  - 702A *Definitions*
  - 703A *Standards of Quality*
  - 704A *Ignition-Resistant Construction*
  - 705A *Roofing*
  - 706A *Vents*
  - 707A *Exterior Covering*
  - 708A *Exterior Windows, Skylights and Doors*
  - 709A *Decking*
  - 710A *Accessory Buildings and Miscellaneous Structures*


Fire Hazard Severity Zones in State Responsibility Area
September 29 2023 - Effective April 1 2024
Find address or place
Lancaster
Palmdale
Victorville
Santa Barbara
Santa Clarita
Simi Valley
Ventura
Oxnard
Thousand Oaks
Los Angeles
El Monte
Ontario
Redlands
Yucaipa
Riverside
Banning
Channel Islands National Park
Santa Monica
Corona
Redondo Beach
Anaheim
Perris
Hemet
Long Beach
Santa Ana
Huntington Beach
Lake Forest
Menifee
Murrieta
Laguna Niguel
San Clemente
Oceanside
20mi
-119.844 34.719 Degrees
Esri, CGIAR, USGS | County of Los Angeles, California State Parks, Esri, TomTom, Garmin, Saf...
esri

What is Wildfire Resistant Construction (WFRC) ?

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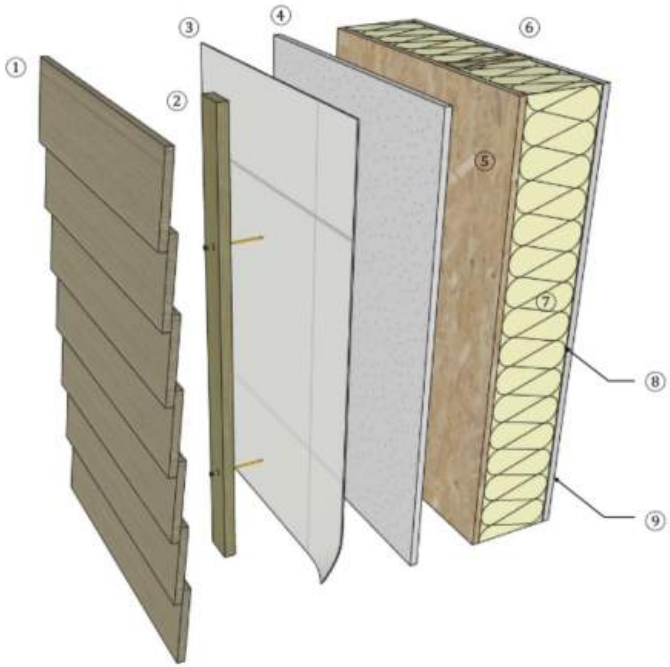
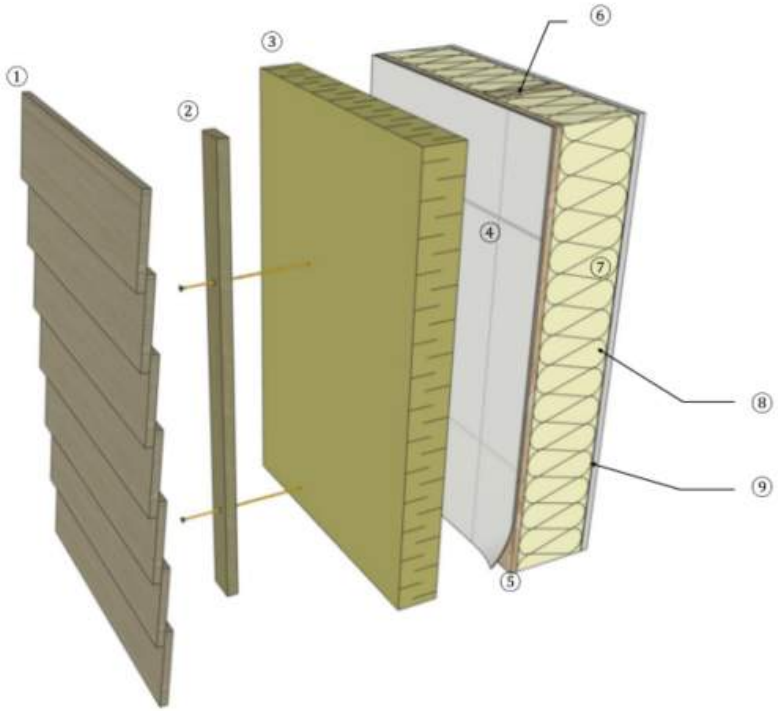
2 Paths for 1h Wildfire Protection for Wood-Framed Structure

Core Wall : Exterior Rated Gypsum Sheathing



Fire & Heat Resistant Exterior Insulation:
Mineral Wool



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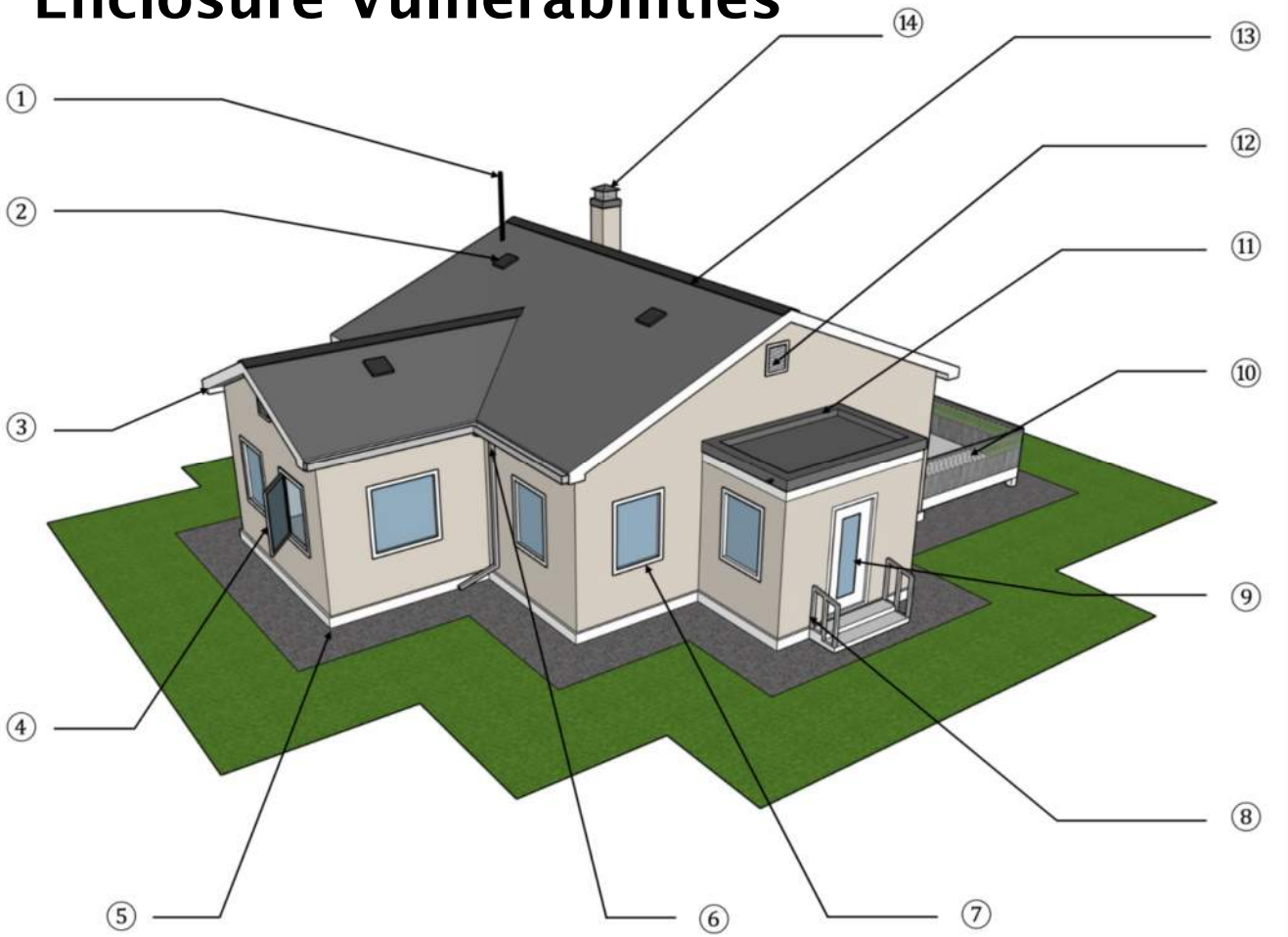
Enclosure Vulnerabilities



LEGEND

① Plumbing and HVAC penetrations
② Roof vents
③ Soffits and soffit vents
④ Operable windows
⑤ Base of wall
⑥ Gutters and downspouts
⑦ Windows and window trim
⑧ Structural connections (guardrails, etc.)
⑨ Doors, door trim and weather stripping
⑩ Decks, balconies and cantilevered floors
⑪ Roof/wall interface
⑫ Gable-end vents
⑬ Ridge vent
⑭ Chimneys

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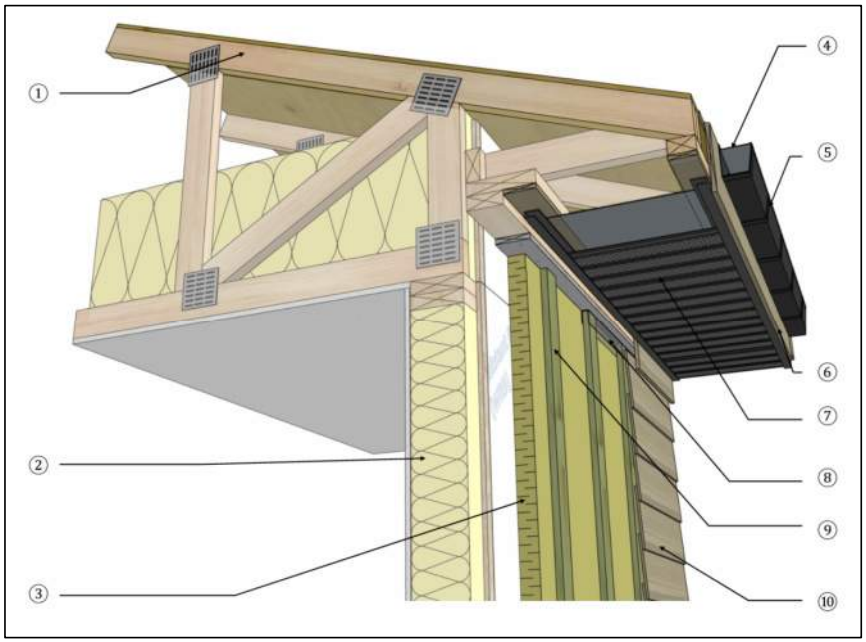
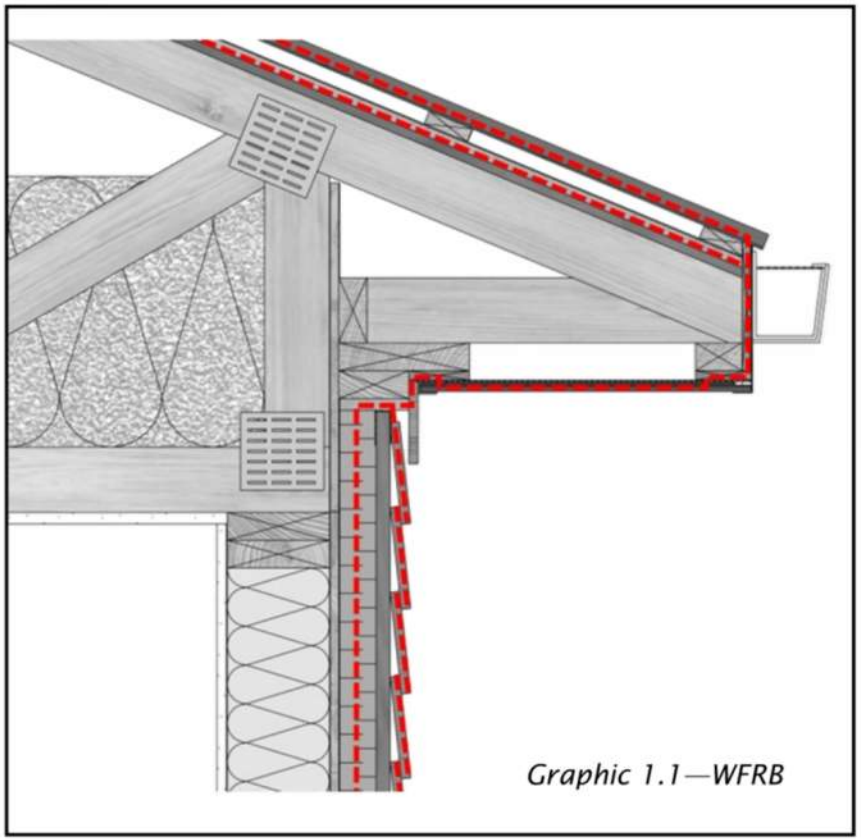
+Importance of Details

- Once the wall assembly is designed and meets the 1h WFRR then develop the building enclosure details for fire protection
- Getting the details correct is just as critical as the assembly design - is a complete system
  - Non-combustible materials
  - Resistant to high temperatures from contact with brands/embers and from radiant heat
  - Block ember entry w/ screens
  - Protect temperature sensitive materials like wood, plastics etc.
- Consider resiliency and post-fire repairs



Wildfire Resistant Barrier (WFRB)

- Same idea as air barrier, vapor barrier, water resistant barrier
- Must be continuous and encapsulate the combustible elements of the building
- Must be able to resist heat and embers



Wildfire Resistant Construction Details

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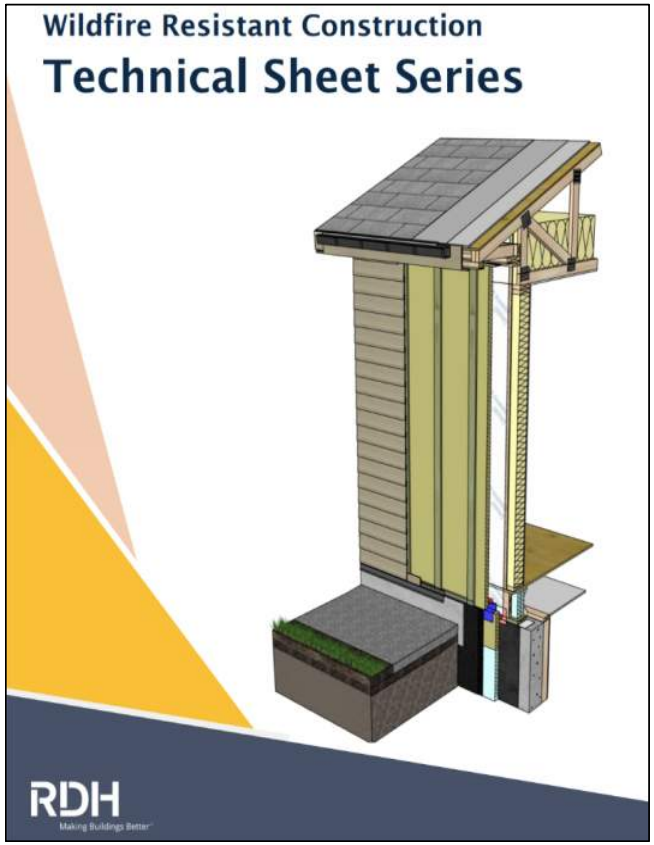
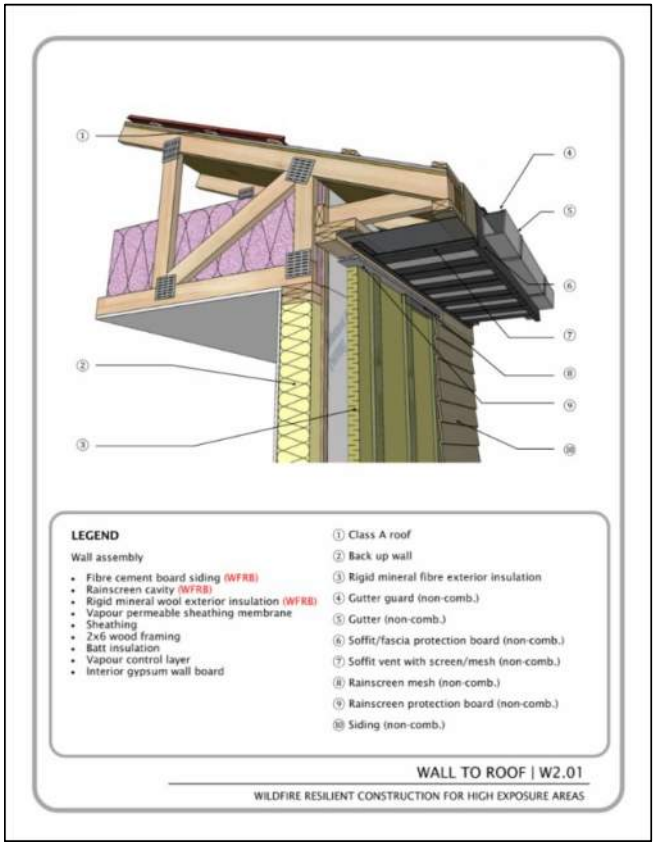
RDH WFRC Technical Sheets & Other Technical Guidelines





ROCKWOOL

Building with ROCKWOOL Stone Wool Insulation in Wildfire-Prone Areas
Technical Bulletin

Wood Frame Construction up to 4 Storeys: Lightweight Cladding.

Intended Use of this Document

This document provides example key assembly interface details showing the use of ROCKWOOL™ products within a split-insulated wall assembly for commercial buildings up to 4 stories.

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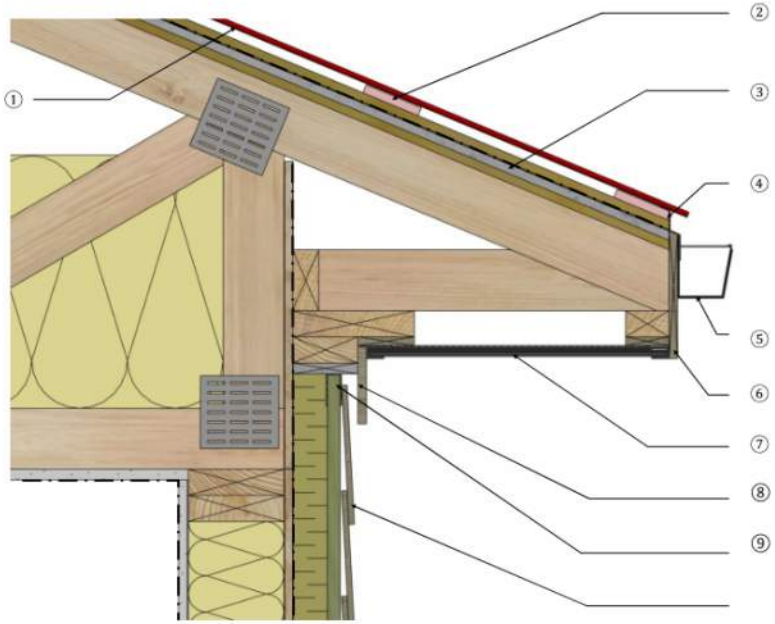
Code Jurisdiction	Building Components			
	Common Requirements	**01 - Roof Covering**	**02 - Walking Surfaces**	**03 - Protection of the Eaves**
California	**R337.7.3. Coverings:** Noncombustible materials - OR - Ignition resistant materials - OR - Fire retardant treated wood. **R337.7.4 Assemblies:** 1-hour fire resistance rated construction - OR - One layer of 5/8" Type X Manual.	**R337.5.1.** ASTM E108 Class A Rating. Where covering has gap between covering and combustible deck, include mineral surfaced nonperforated cap sheet over combustible decking Add bird stops at eaves to prevent debris. Caps shall be mudded in to prevent fire ember intrusion. EXCEPTION: Cap sheet not required when no less than 1 inch of mineral wool board or other noncombustible materials is located between the roofing material and wood framing or deck. Can also use fire retardant deck material if no cap sheet is provided.	**R337.9** Walking surfaces of decks, porches, balconies and stairs within 10' of buildings	**R337.7.5 and 337.7.6** **Refer to Common Requirements.** EXCEPTION: Trim and fascia boards.

Code Jurisdiction	Building Components			
	04 - Gutters and Downspouts	**05 - Exterior Walls**	**06 - Foundation Walls**	**07 - Underfloor Enclosure**
California	**R337.5.4** Roof gutters provided with means to prevent accumulation of leaves and debris.	**R337.7.3 and 337.7.4** Exterior coverings, wall assemblies, eave overhangs, soffits, porch ceilings, floor projections, and underfloor areas **Refer to Common Requirements.** Top of foundation to roof, terminated with 2" nominal solid wood blocking between rafters at all roof overhangs. Where enclosed eaves, terminate at the enclosure. Trim, fascias, embellishments, fascias, and gutters excluded.	-	**R337.7.9** **Refer to Common Requirements** - OR - Enclosed to grade. EXCEPTION: Structural columns and beams do not require protection where they are heavy timber 4" nominal or more.

Code Jurisdiction	Building Components			
	08 - Appendages and Projections	**09 - Exterior Glazing**	**10 - Exterior Doors**	**11 - Vents**
California	**R337.7.10** Underside of Appendages: **Refer to Common Requirements.** EXCEPTION: Structural columns and beams do not require protection where they are heavy timber 4" nominal or more.	**R337.8.2** 1. Tempered, multi pane glass, 2. Glass blocks, 3. 20-min fire resistance rating per NFPA 257 4. Tested to SFM 12-7A-2 Openable skylights require non-combustible screen with mech apertures limited to 1/8" (3.2 mm).	**337.8.2. Exterior glazed doors:** Tempered, multi pane glass, -OR- Glass blocks, -OR- 20-min fire resistance rating per NFPA 252 -OR- Tested to SFM 12-7A-2 337.8.3. Exterior non-glazed doors Surface / Cladding is non-combustible / ignition resistance, -OR- Solid core wood with panels 1 1/4" thick, -OR- 20-min fire resistance rating -OR- Tested to ASTM E2707 or SFM 12-7a-1.	**337.6.2.** Vent openings to be wildfire flame and ember resistant approved by the fire marshal, -OR- Tested to ASTM E2886. Vents on sloped roofs shall be covered with a non-combustible, corrosion-resistant screen with a mesh aperture less than 1/8" (3.2mm).



LEGEND

Wall assembly

- Fibre cement board siding (WFRB)
- Rainscreen cavity (WFRB)
- Rigid mineral wool exterior insulation (WFRB)
- Vapor permeable sheathing membrane
- Sheathing
- Wood framing
- Batt insulation
- Vapor control layer
- Interior gypsum wall board

① Class A roof

② Fire resistant treated wood or non-comb. strapping

③ Protection board (non-comb.)

④ Bug and ember screen (non-comb.)

⑤ Gutter and gutter guard (non-comb.)

⑥ Soffit/fascia protection board (non-comb.)

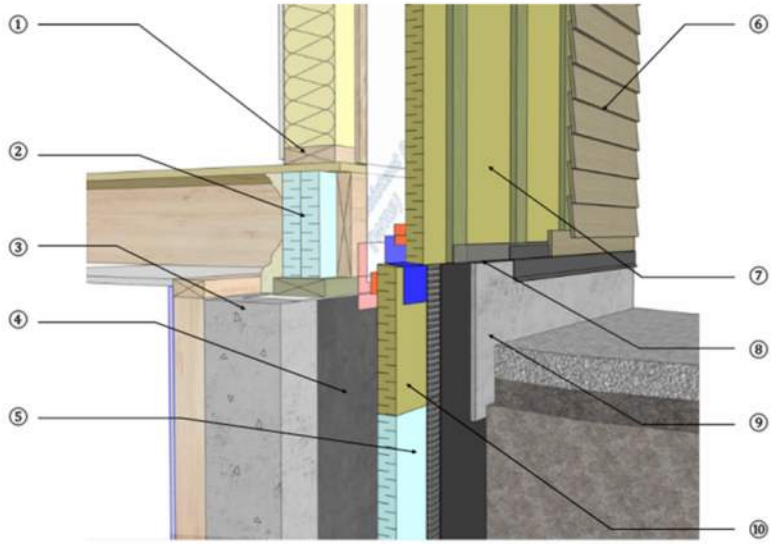
⑦ Soffit vent with screen/mesh (non-comb.)

⑧ Rainscreen protection board (non-comb.)

⑨ Rainscreen mesh (non-comb.)

WALL TO VENTED SOFFIT (METAL ROOF) | R1.04

WILDFIRE RESISTANT CONSTRUCTION FOR HIGH EXPOSURE AREAS



LEGEND

Wall assembly

- Fibre cement board siding (WFRB)
- Rainscreen cavity (WFRB)
- Rigid mineral wool exterior insulation (WFRB)
- Vapor permeable sheathing membrane
- Sheathing
- 2x6 wood framing
- Batt insulation
- Vapor control layer
- Interior gypsum wall board

① Wood frame wall

② Floor assembly

③ Below grade concrete wall

④ Damproofing

⑤ Below grade exterior insulation (comb.)

⑥ Siding (non-comb.)

⑦ Rigid mineral wool insulation (non-comb.)

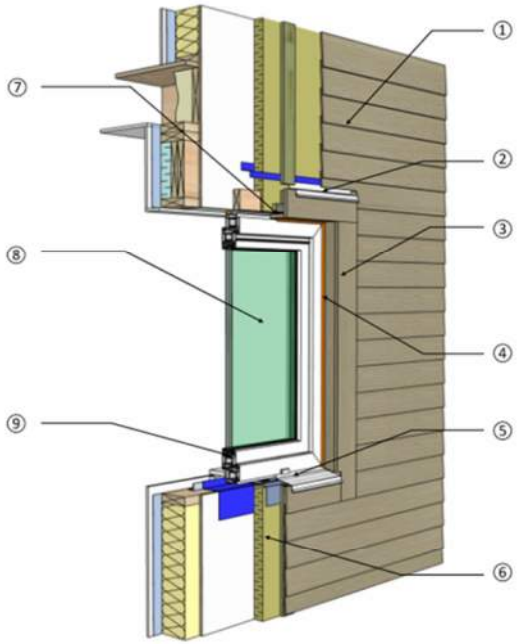
⑧ Bugscreen (rainscreen cavity)

⑨ Concrete protection board (non-comb.)

⑩ At-grade rigid mineral wool ins. (non-comb.)

BASE OF WALL | W1.05

WILDFIRE RESISTANT CONSTRUCTION FOR HIGH EXPOSURE AREAS



LEGEND

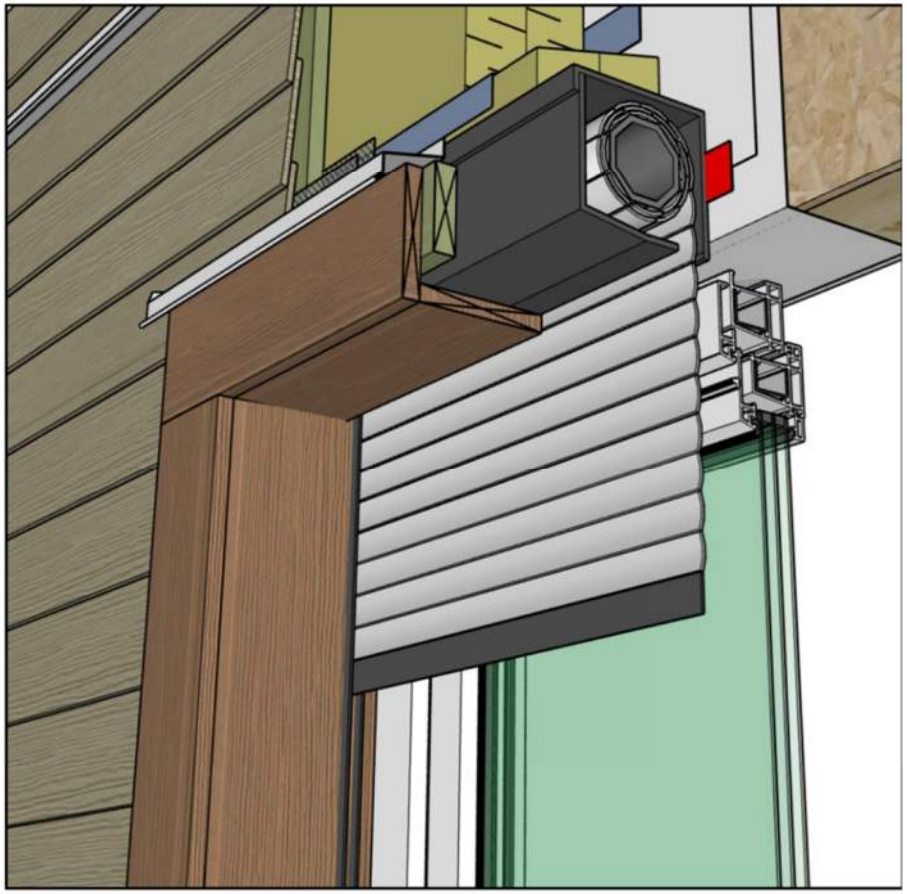
Wall assembly

- Fibre cement board siding (WFRB)
- Rainscreen cavity (WFRB)
- Rigid mineral wool exterior insulation (WFRB)
- Vapor permeable sheathing membrane
- Sheathing
- 2x6 wood framing
- Batt insulation
- Vapor control layer
- Interior gypsum wall board

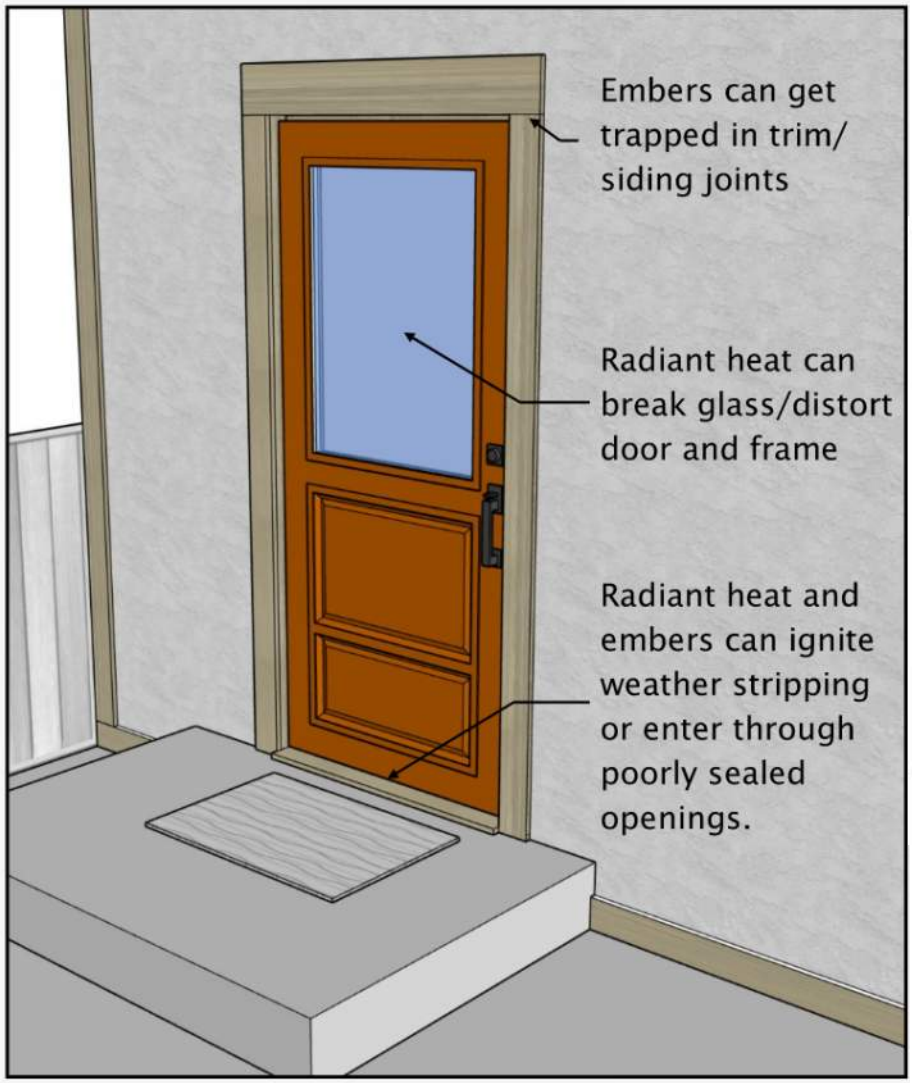
① Siding (non-comb.)
② Head flashing (non-comb)
③ Window trim (non-comb)
④ Fireproof sealant around exterior perimeter
⑤ Sill flashing (non-comb)
⑥ Rigid mineral wool exteiror insulation
⑦ Screen/mesh (non-comb)
⑧ Multi-pane window incl. one tempered pane
⑨ Window frame (fire resistant)

WINDOW | WI1.01

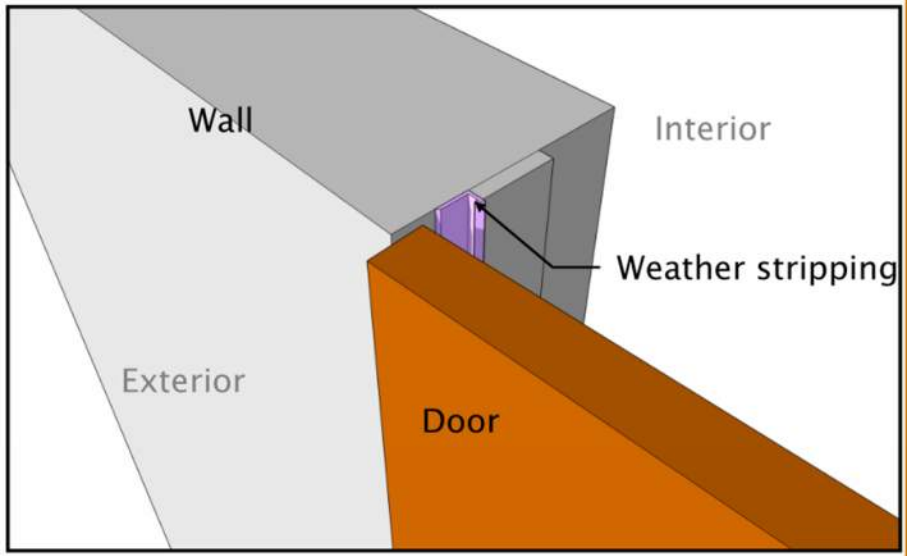
WILDFIRE RESISTANT CONSTRUCTION FOR HIGH RISK EXPOSURE AREAS



Graphic 1.1— Integrated exterior fire shutter



Graphic 1.1— Weak points in exterior door

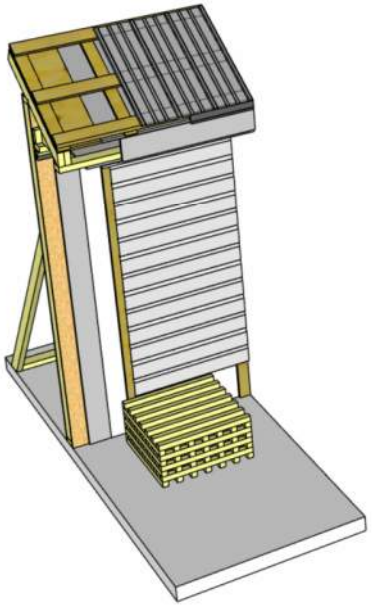


Graphic 1.2— Protected weather stripping

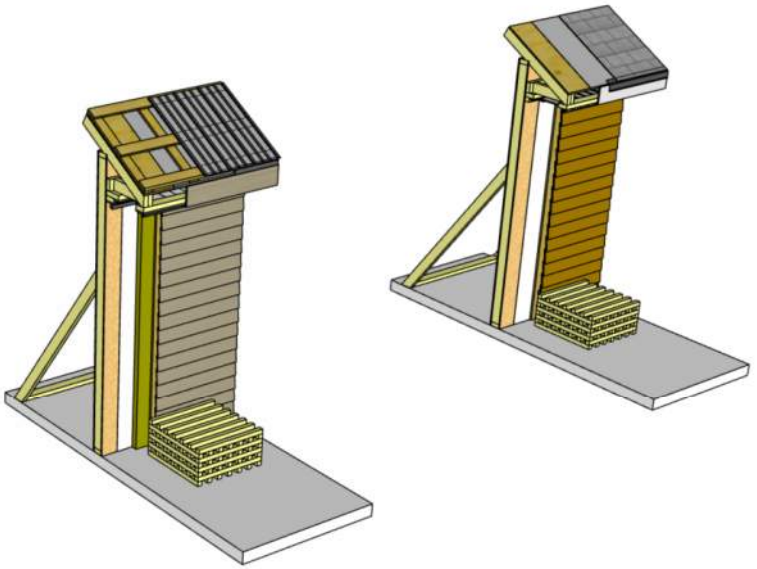
RDH Field Testing & Demonstration Burn

- **Three Wood-frame Wall Assemblies:**
- Two 1h WFRR Wall Options
  - **Core Wall** w/ Gypsum Sheathing
  - **Exterior Mineral Wool** Insulation
- One conventional wall, with no exterior fire rating, representing typical wood-frame home reference

Gypsum Sheathing & Vinyl Siding



Unprotected with wood siding



Mineral Wool & Fiber Cement Siding

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Gypsum Sheathing & Vinyl Siding
Mineral Wool & Fiber Cement Siding
Unprotecte d with wood siding

Unprotected with wood siding

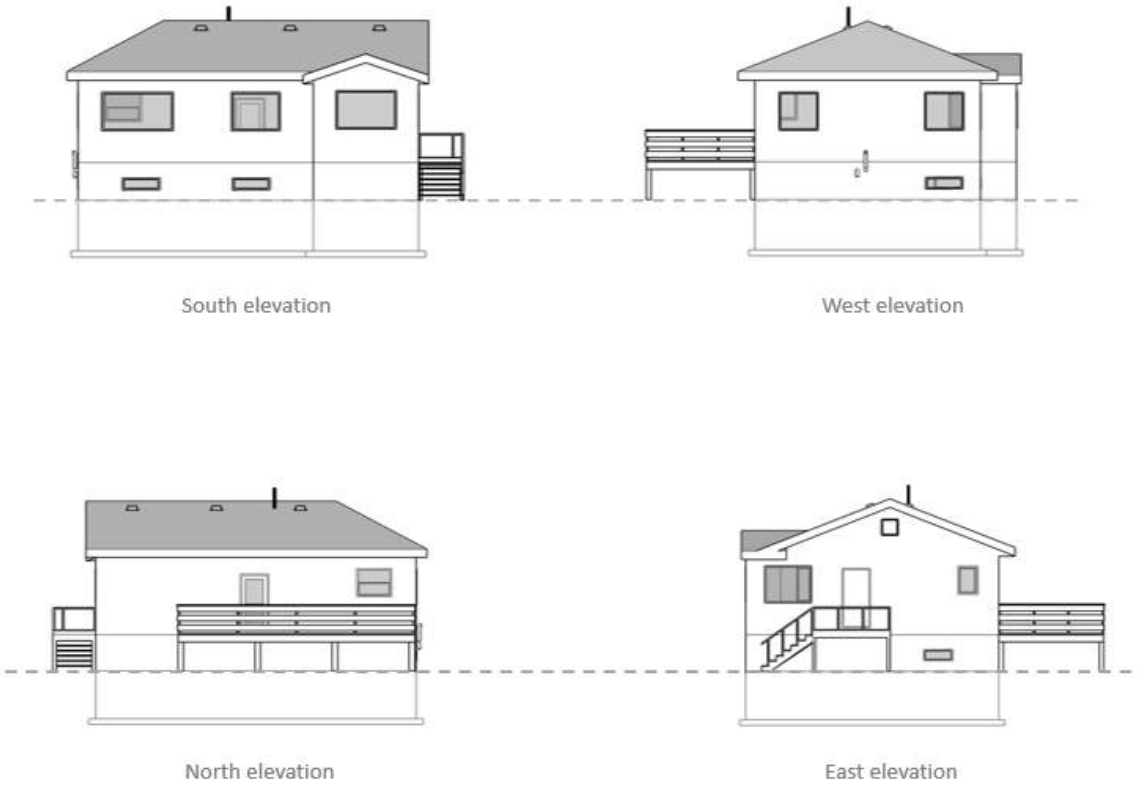
Gypsum Sheathing & Vinyl Siding

Mineral Wool
& Fiber
Cement
Siding

Cost Analysis

How much does it cost?

- Developed archetype house
  - 2000 sf
  - ¾ basement
- Asked local contractors to cost out requirements
  - Typical construction
  - Wildfire-resilient construction
- QTOs and material options provided



Archetype House

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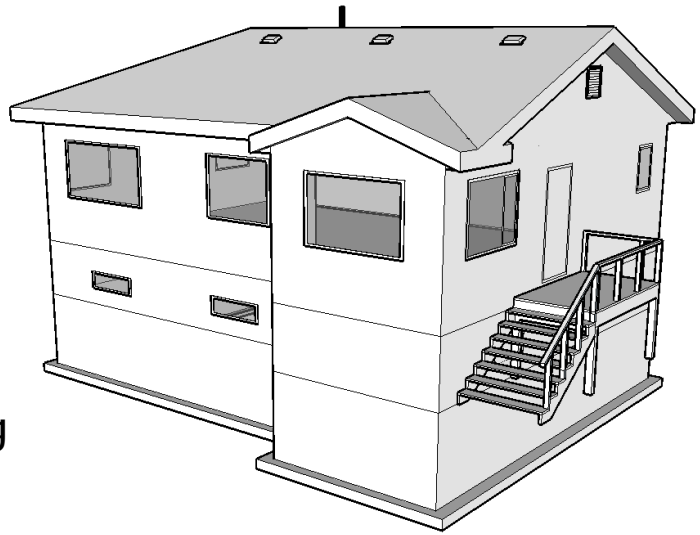
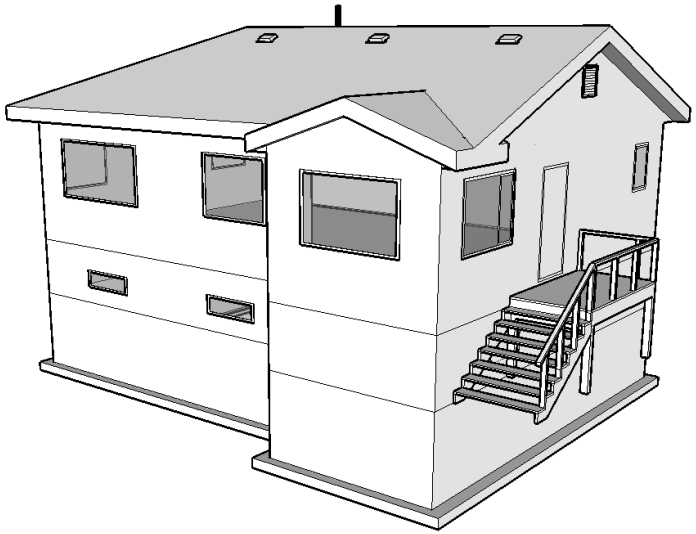
Typical house

- Asphalt fibreglass composition shingle roof
- Engineered wood eave and fascia
- Hardieplank lap siding
- Double-pane windows, argon-filled, LowE coating
- Combustible vents and flashing
- Typical screen frames for operable windows
- Concrete foundation
- Wood or fibreglass exterior doors
- Window to wall ratio ~0.20



Wildfire-resilient house



- Asphalt shingle roof
- Non-combustible pipes and vents
- Non-combustible flashing and trim
- 1.5” mineral wool exterior insulation, or 5/8” Type-X gypsum exterior sheathing
- Fibre cement siding
- All ventilation openings include metal screen
- All gaps greater than 1/8” are sealed
- Double-pane windows, argon-filled, LowE coating with tempered outer pane
- Concrete foundation with non-combustible protection board
- Fire rated exterior doors
- Window to wall ratio ~0.20

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Preliminary Results

- Many things didn't change, ie. not common to use vinyl gutters and downspouts and asphalt fibreglass composite shingles are used everywhere
- Fire rated wall assembly adds cost
- Tempered glass adds to window package total cost
- Non-combustible trim and flashings more costly/time consuming
- Fire-rated doors might be an issue for high performance homes
- Approximately 2% cost increase for above-code design can result in significant safety and financial savings of approximately $4 for every $1 spent on mitigation.

Additional Resources

Additional Resources

- Rockwool/RDH Technical Bulletin: https://www.rockwool.com/syssiteassets/o2-rockwool/documentation/technical-bulletins/residential/rockwool—building-with-stone-wool-in-wildfire-prone-areas.pdf?f=20250311140839
- SFPE WUI Handbook: https://www.sfpe.org/wuihandbook/home
- NFPA Wildfire Resources: https://www.nfpa.org/education-and-research/wildfire
- 2022 CBC – Chapter 7A: https://up.codes/viewer/california/ca-building-code-2022/chapter/7A/sfm-materials-and-construction-methods-for-exterior-wildfire-exposure#7A
- Calfire WUI Listed Products: https://osfm.fire.ca.gov/what-we-do/fire-engineering-and-investigations/building-materials-listing
- IBHS Wildfire Research: https://ibhs.org/risk-research/wildfire/
- AIACA Hardening for Wildfire Resilience: https://aiacalifornia.org/news/hardening-for-wildfire-resilience/
- Continuing Education: Wildfire-Adapted Design: https://www.architecturalrecord.com/articles/14853-continuing-education-wildfire-adapted-design#continuing-education
- Sustainable Defensible Space - www.defensiblespace.org

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Discussion + Questions

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