



Parcel and Structure Assessment for Wildfire Hardening Best Practices

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Funded by Energy Codes and Standards –
Southern California Edison



*Funded by Energy Codes and Standards
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Learning Objectives

1. **Burn Test Study (K&A Building Science & SCE)**
2. **Wildfire Hardened Displays - SCE Energy Education Center**
3. **Parcel Assessment for Wildfire Hardening (PAWH) Form**
4. **Energy Impacts**
5. **Key Points and Final Thoughts**



Learning Objective #1

Burn Test Study



San Bernardino Regional Emergency
Training Center
January 30th, 2024



U-Stucco being installed.

Goal

- To test ignition resistant & non-combustible building materials as an advanced framed assembly to stand alone & survive the full duration of a fully involved residential fire in a high-density setting.
- Structures facing each other, not side by side.



Residential Fires

- What is the average duration of a residential fire?
- How hot is a residential fire?



Residential Fires

- **The average duration = 60 minutes**
 - 15 minutes up to 3 hours
- **The average temperature = 1,600° F**
 - Extreme fuels and winds = 2,000° F



Burn Structure -

- Needs to last 60 minutes
- Produce direct flame & radiant heat exposures of 1,600° F



Burn Structure -

- Conventionally framed 2"x6"x16" o/c
- Open eave
- Vented attic
- Wood siding
- Insulated, drywalled and taped
- No defensible space
- Combustibles in the 0'-5' zone around the structure

Conventionally Framed

- **2"x6" lumber 16" O.C.
(on center)**
- **More fuel**



- **Open Eave**
- **Vented Attic**
- **Wood Siding**



Insulated, Drywall and Vinyl Window



A lot of wood furniture!



- Standard wood door
- No defensible space
- Combustibles in the 0'-5' zone around the structure





Hardened Structure -

- Advanced framing 2" x 6" x 24" o/c (Less fuel)
- Closed eave
- Unvented attic
- Non-combustible siding
- Insulated, drywall and taped
- 60-minute fire rated window
- 60-minute fire rated door
- Defensible space – Zone 0 (0'-5')
- SSD 10' from neighboring structure

Hardened Structure - Construction

Advanced Framing 24" o/c Single
Top Plate and 2-Stud Corners



Site-Built Trusses



Hardened Structure - Construction

Fiberglass Batts & Mineral Wool



Drywall & taped for air seal



SAFTIFIRST 60 min. Fire Rated Window

Steel Clips



Steel Square Tubing



SAFTIFIRST 60 min. Fire Rated Window

Mineral Wool – Thermal Barrier



Gypsum Filled Aluminum Caps



SAFTIFIRST 60 min. Fire Rated Window

*Interior View – Ready for
Glazing*



Double-Pane Non-Operable



SAFTIFIRST 60 min. Fire Rated Window

Interior View



SPECIFICATION

SECTION 08 88 13: FIRE-RATED GLAZING
SuperLite® II-XL 60 minute and SuperLite® II-XL 60 minute
with Starphire Ultra-Clear® Glass by Vitro

Unvented Attic and Enclosed Eaves



Non-Combustible Exterior Siding & Roofing

Lathing



U-stucco: Single Coat
(7/8"-1" R2 per inch)



60 min. Fire Rated Door

Steel Door Jamb



Intertek 1-Hour Fire Door



Standard Steel Fence

5' Tall



K&A Fabricated Supports



Standard Vinyl Fence (5' from each structure)

Supports for the Vinyl Fence



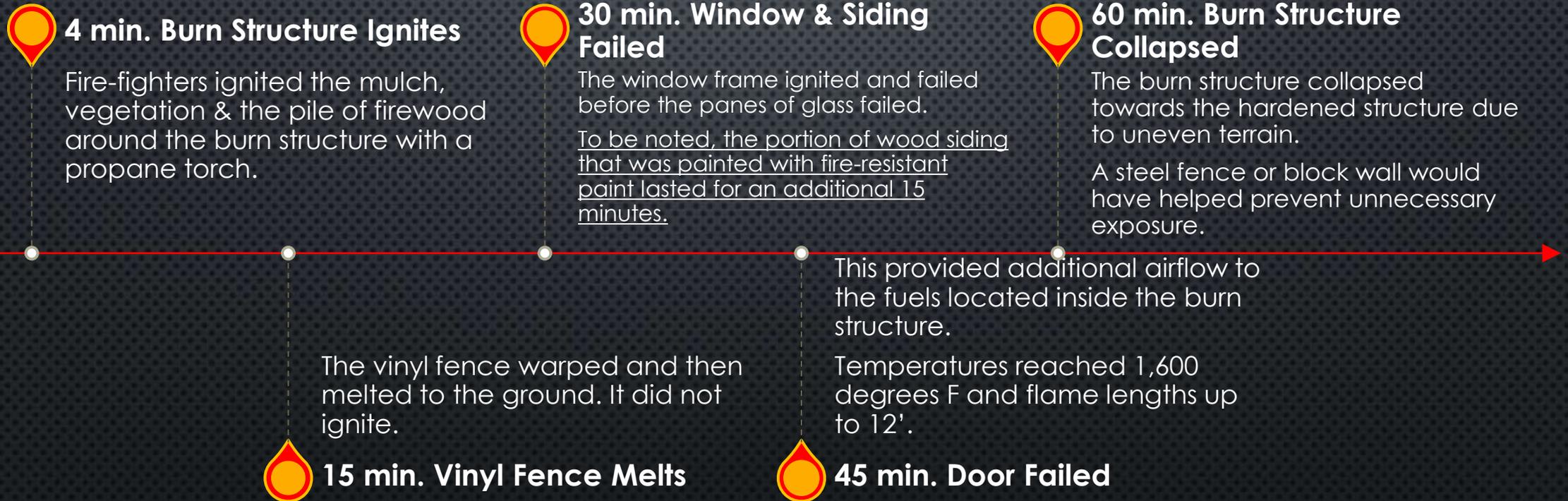
Free Standing Fence



FR-Clear Coating or Paint: Red Taped Sections



Burn Structure Timeline



VIDEO

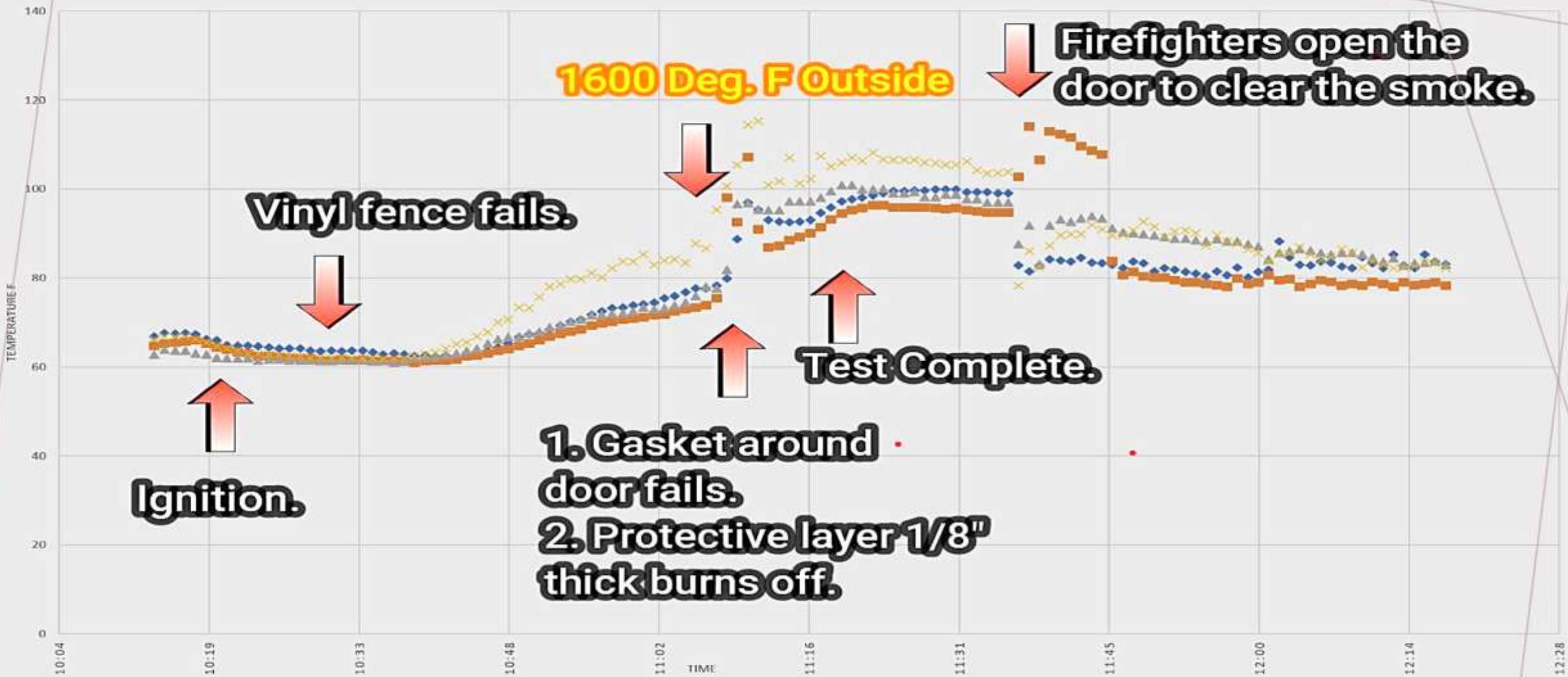


Video:
Kliwer and Associates performs
Burn Test for SCE

https://youtu.be/VJKS_qSk9P4?si=eJ2hNJUi3e8pp1jU

BURN TEST - TEMPS INSIDE FORTIFIED STRUCTURE

◆ CH1 ■ CH2 ▲ CH3 × CH4



Ignition.

Vinyl fence fails.

1600 Deg. F Outside

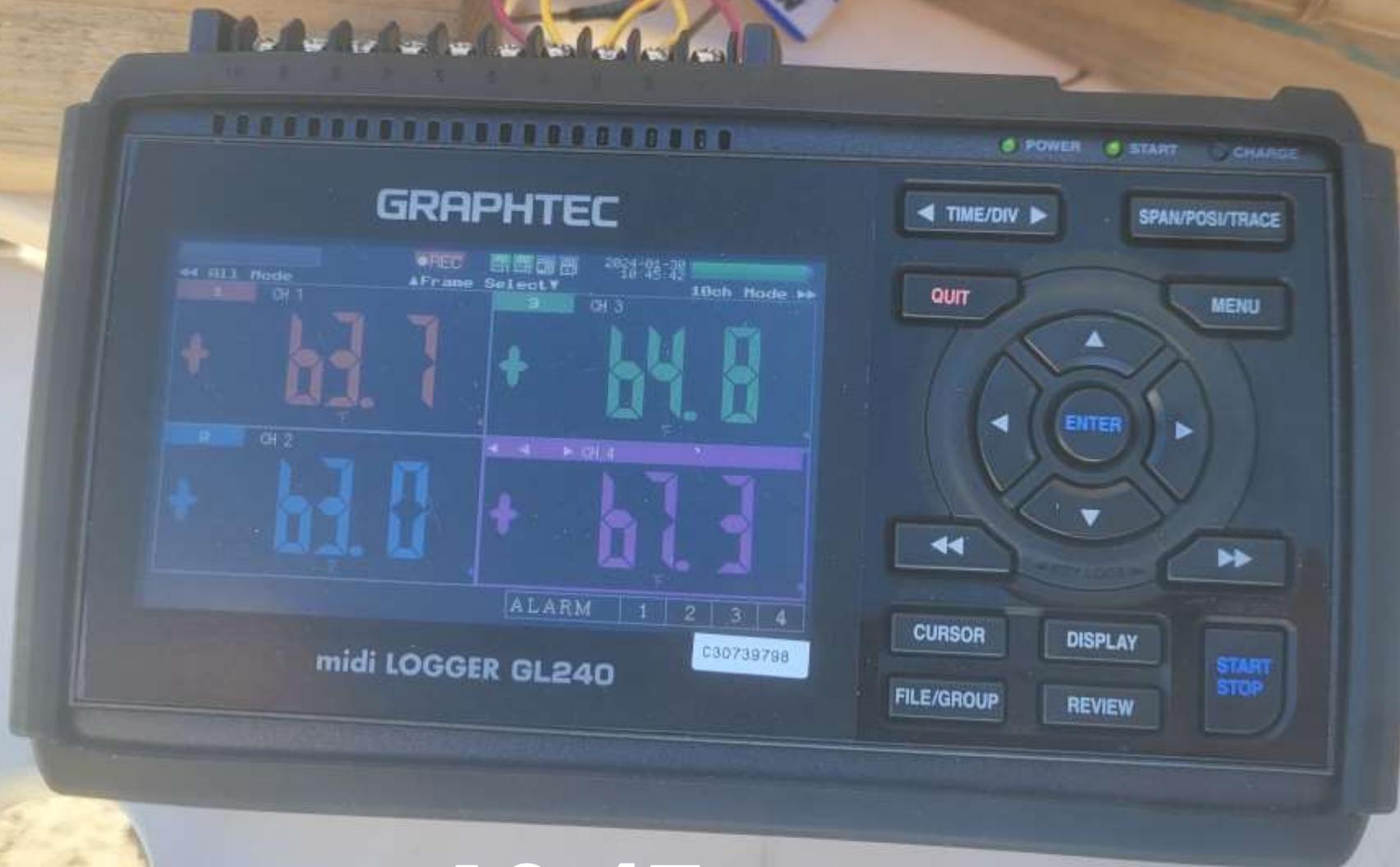
Firefighters open the door to clear the smoke.

Test Complete.

**1. Gasket around door fails.
2. Protective layer 1/8" thick burns off.**

Channel Legend:

| | |
|-------|----------------------|
| ◆ CH1 | 1 Behind Window |
| ■ CH2 | 2 Behind Middle Door |
| ▲ CH3 | 3 Behind Top Door |
| × CH4 | 4 Ceiling |



10:47 am



11:18 am

Vinyl fence melts and does not sustain flame.



FR-Paint & Coating

FR-paint provided 15 minutes of protection.

Neither are approved in California building codes.





We Did Not Anticipate

- The burn structure collapsing towards the hardened structure.
- Building materials may have to withstand impact.
- Steel fence or a concrete block wall.
- Wildfire events may have extremely high winds and debris that may fall onto or against your structures.



Design met the anticipated exposure.

- Advanced framing 2" x 6" x 24" o/c (Less fuel)
- Closed eave
- Sealed attic
- Non-combustible siding
- Insulated, drywalled and taped
- 60-minute fire rated window
- 60-minute fire rated door
- Defensible space
- SSD 10' from neighboring parcel



Forensic Study

1/8" Layer on the 60min. FR-Door Contributes to Direct-Flame Exposure to the Closed Eave.



Observations

- Eaves trap heat
- **Extremely vulnerable to ignition**
- Relatively easy to enclose with non-combustible materials



Recommendations

- If attics are vented, use ember and fire-rated vents with 1/16"-1/8" openings. Options may include:
 - Stainless steel wire (looks like steel wool).
 - Intumescent firestop materials; Expands when heated which closes the screened openings preventing ember and direct flame exposure.
 - Replaceable cartridge design.
 - Metal louvers over the screen mesh prevents the screen mesh being painted over.



60-Minute Fire Rated Door

1/8-inch layer burned off.



Fire Resistant Core



1-Hour Fire Door (UL10C/NFPA 252)

Intertek 1-Hour Fire Door



Aluminum threshold survived
(melts at 1,221 degrees F)



Steel Door Jamb

Timely galvanized steel door frame.



Fiber cement board 0.25" provided a thermal break.



Heat Transfer at the Hinges

Concentrated heat at the door hinges.

Critical Information

Fiber cement & drywall withstood heat transfer.

Wood stud was scorched at steel hinge.



Recommendations

- Ensure the steel door frame is installed over noncombustible materials such as drywall or fiber cement board.
- Use thermal breaks to prevent heat transfer.
- Caulk any gaps with fire rated caulking or intumescent materials in through-hole penetrations.



Door Recommendations

- **60–120-minute fire-rated door.**
 - **Highest rating possible when fuel or structure exposures are less than 30' (High-density).**
- **Must include the equivalent rated door jamb & weather stripping.**
 - **If steel, install 1/4" fiber cement board between the steel door jamb and wood framing.**



Non-Combustible Siding & Roof: U-Stucco

Second burn test performed by placing wood directly against the single coat u-stucco (R2 per inch)

- Regular stucco R0.20
- **Energy Efficiency (EE) gain**



Non-Combustible Siding/Roof: U-Stucco

Did heat transfer through?

No damage



Non-Combustible Siding/Roof: U-Stucco

Cracking from installation



No damage to wood sheathing or underlayment



Heat did not transfer through U-Stucco



SAFTIFIRST 60min. Fire Rated Window (ASTM E119)

Superlite II-XL

Intumescent Interlayer
Expands



SAFTIFIRST 60min. Fire Rated Window

*The gypsum pack plastic coating
heated up enough to stick to the steel tubing*



Wood framing undamaged



Conclusion –

Hardening and Defensible Space Provide:

- Additional time for residents to escape
- More time for first responders to arrive
- A safer working environment for first responders to defend the structure
- Did not contribute to the spread of embers
- Evidence that structures can be designed to stand-alone against wildfires

Recent 2025 Palisades Fire



Learning Objective 2: Southern California Edison Energy Education Center Wildfire Hardened Module Pullouts



6090 Irwindale Ave, Irwindale, CA 91702
800-336-2822

**SCE Building
Envelope
Classroom –
Wildfire
Hardened Pull-
Out Modules
and How to
Meet T24 Part 7
2025 California
Wildland-Urban
Interface Code**





MODULE #3

ROOF

- 1 Concrete Roof Tiles (w/bird stops)
- 2 O'Hagin Fire & Ice Vent
- 3 2 layers of 30lb underlayment
- 4 LP Flame-block Sheathing
- 5 Drip edge steel flashing
- 6 Fascia fiber cement siding
- 7 Fire rated caulking

THICKNESS R-VALUE

| | |
|------------|------|
| 1" | 0.08 |
| 26 Gauge | N/A |
| 1.2mm | 0.12 |
| 7/16" | 0.55 |
| 26 Gauge | N/A |
| 1/4" | 0.13 |
| smoke seal | |

FIRE RATING

Class A
ASTM E2886

ASTM E84/UL 723
Noncombustible
ASTM E84/E136/C177
ASTM E814 (UL1479)

WALL

- 8 Raised-heel truss
- 9 Open cell spray foam
- 10 2x6 single top plate
- 11 3x6 framing connector
- 12 Drywall
- 13 Inside Air Film
- 14 Drywall backing clips
- 15 2x6 studs @24" on center
- 16 2-stud corner
- 17 Open cell spray foam
- 18 OSB shear panel
- 19 Weather Resistant Barrier (WRB) - Tyvek
- 20 Insulating Fireproof U-Stucco
- 21 Safti-First Superlite II-XL 60min. FR Glazing
- 22 Steel Frame
- 23 Mineral Wool
- 24 Gypsum Core/ Aluminum Cap
- 25 Slab on grade (simulated)

| | |
|---------------|------|
| 24" On Center | N/A |
| 10.55" | 38 |
| 1.5" x 5.5" | 5.5 |
| 20 Gauge | N/A |
| 0.5" | 0.45 |
| | 0.68 |
| | 0 |
| 1.5" x 5.5" | 5.5 |
| | 5.5 |
| 5.5" | 19.8 |
| 7/16" | 0.51 |
| 0.0087" | 2 |
| 7/8" | 2 |
| 1-7/8" Low-E | 1.14 |
| | N/A |
| 2" | 8.4 |
| | N/A |

Class 1

ASTM E136/E-04

Class 1

Class A
Class 1
ASTM E119/NFPA 251

Not Rated

IWUIC - IGNITION
RESISTANT CONSTRUCTION
CLASS 1

| | |
|-----------------------|-------|
| ROOF FRAMING FACTOR | 6.8% |
| ROOF ASSEMBLY U-VALUE | 0.026 |
| WALL FRAMING FACTOR | 17% |
| WALL ASSEMBLY U-VALUE | 0.044 |

Module 3 – Roof Assembly



Module 3 – Wall Assembly





MODULE #6

| ROOF | | THICKNESS | R-VALUE | FIRE RATING Class A ASTM E108 UL Listed Type G3 Capsheet Class A/ASTM E84/UL 723 ASTM E84/UL 723 Noncombustible ASTM E84/E136/C177 Intumescent Vent <Class 1 Not Rated Class A/ASTM E84/UL 723 Class A Class A/ASTM E84/UL 723 Noncombustible Noncombustible IWUIC - IGNITION RESISTANT CONSTRUCTION CLASS 3 * <small>*Remove the eave vent = Class 1</small> |
|------|--|--------------|---------|--|
| 1 | Concrete roof tiles (Incl battens & air space) | 2" | 2.95 | |
| 2 | SOL-R-SKIN FR-underlayment | 1/8" | 5.5 | |
| 3 | 72lb Mineral surfaced cap sheet | 1/8" | 0.34 | |
| 4 | Rockwool mineral wool insulation board | 1" | 4.2 | |
| 5 | LP Flame-block sheathing | 7/16" | 0.55 | |
| 6 | Drip edge steel flashing | 26 Gauge | | |
| 7 | Fascia fiber cement siding | 1/4" | 0.13 | |
| 8 | Ember & fire rated vent | 2.13" | | |
| 9 | Engineered raised-heel truss | | | |
| 10 | Blown-in Cellulose (R3.1/in) | 12.25" | 38 | |
| WALL | | | | |
| 11 | 2x6 single top plate | 1.5"x 5.5" | 5.5 | |
| 12 | 2x6 studs @24" on center | 5.5" | | |
| 13 | Optimum Window 60min. FR Glazing | 1-7/8" Low-E | | |
| 14 | Air Seal Plumbing and Wiring Penetrations | | N/A | |
| 15 | Rockwool mineral wool batts | 5.5" | 22 | |
| 16 | Gypsum wall board | 1/2" | 0.45 | |
| 17 | OSB sheathing | 7/16" | 0.51 | |
| 18 | Weather Resistant Barrier (WRB) - Tyvek | 0.0087" | 2 | |
| 19 | Rockwool mineral wool insulation board | 1" | 4.2 | |
| 20 | Fiber cement vertical siding | 1/4" | 0.13 | |
| 21 | Fiber cement batten trim | 3/4" | N/A | |
| 22 | Galvanized steel Z bar flashing | 26 Gauge | | |
| 23 | Fiber cement lap siding | 1/4" | 0.13 | |
| 24 | Galvanized steel 6" flashing | 26 Gauge | | |
| 25 | Ceramic tile N/A | | | |
| 26 | Inside Air Film | | 0.68 | |
| 27 | 15lb felt paper | 1/16" | 0.06 | |
| 28 | Slab on grade (simulated) | | N/A | |

ROOF FRAMING FACTOR 6.8%

ROOF ASSEMBLY U-VALUE 0.020

WALL FRAMING FACTOR 17%

WALL ASSEMBLY U-VALUE 0.035

Module 6 – Roof Assembly



Module 6 – Wall Assembly





Learning Objective #3

Parcel Assessment for Wildfire Hardening (PAWH) form

Best Practices

Parcel Assessment for Wildfire Hardening (PAWH)

| 1 Parcel Information | |
|---|--|
| Assessor: | Date: Year Built: |
| Property Address: | |
| Property Owners: | |
| Phone #: | Email: |
| Fire Hazard Severity Zone: | Housing Density Type: |
| Ignition-Resistant Construction Class: <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 | FireWise Community: <input type="checkbox"/> Yes <input type="checkbox"/> No |

2 Parcel Image

Insert an image showing a birdseye view of the parcel and neighboring parcels.



3 Parcel Images (Take pictures of the residence from each corner of the parcel)



Who can use the PAWH form?

- Homeowners
- Communities
- Architects
- Insurance carriers
- Local fire departments
- Inspectors
- Building Officials

Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

1) Parcel Information

- 1) Fire Hazard Severity Zone
- 2) Housing Density Type
- 3) Ignition Resistant Construction Class 1, 2, or 3 (2024 IWUIC)
- 4) FireWise Community

2) Parcel Image (Birdseye view)

3) Parcel Images

- Take a picture of the residence from each corner of the parcel towards the residence.

Parcel Assessment for Wildfire Hardening (PAWH)

| 1 Parcel Information | |
|---|--|
| Assessor: | Date: Year Built: |
| Property Address: | |
| Property Owners: | |
| Phone #: | Email: |
| Fire Hazard Severity Zone: | Housing Density Type: |
| Ignition-Resistant Construction Class: <input type="checkbox"/> 1 <input type="checkbox"/> 2 <input type="checkbox"/> 3 | FireWise Community: <input type="checkbox"/> Yes <input type="checkbox"/> No |

2 Parcel Image

Insert an image showing a birdseye view of the parcel and neighboring parcels.



3 Parcel Images (Take pictures of the residence from each corner of the parcel)

| | | | |
|-----------------------------|--|-----------------------------|--|
| <input type="checkbox"/> NW |  | <input type="checkbox"/> NE |  |
|-----------------------------|--|-----------------------------|--|

Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

3) Parcel Images (Continued)

4) Fire Hazard Severity Zone Viewer Map:

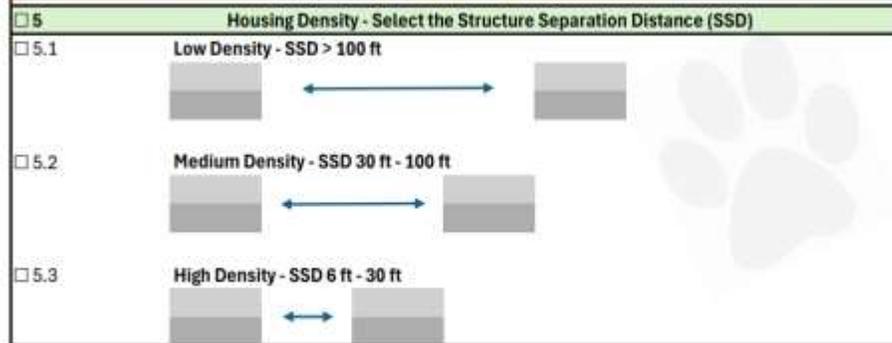
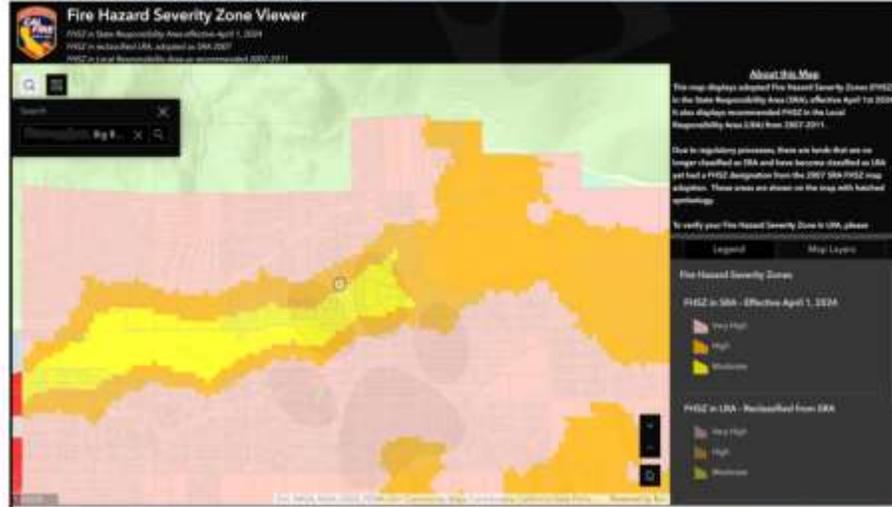
High – FHSZ but surrounded by Very High FHSZ.

5) Housing Density -

Based on the Structure Separation Distance (SSD)



4 FHSZ Viewer Image
<https://experience.arcgis.com/experience/03baab8511814e79a0e4eabf0d3e7247/>



Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

6) ADU/Shed/Detached Garage –

- Based on the Structure Separation Distance (SSD)

7) Wildland-Urban Interface (WUI)

- Intermix, Perimeter, or Interior

8) Housing Density Type -

- Based on the NIST Technical Note 2205 (March 2022)

6 ADU/Shed/Detached Garage - Structure Separation Distance (SSD)

6.1 **Low Density - SSD > 100 ft** **What type of structure & how many?**



6.2 **Medium Density - SSD 30 ft - 100 ft** **What type of structure & how many?**



6.3 **High Density - SSD 6 ft - 30 ft** **What type of structure & how many?**



7 Wildland-Urban Interface - Intermix, Perimeter, or Interior?

0 - miles  0.25 miles 

| | | |
|--|------------------------------------|-----------------------------------|
| Wildlands Single Family Residence Intermix | Community Interface - Perimeter | Community Interface - Interior |
| 7.1 <input type="checkbox"/> | 7.2 <input type="checkbox"/> | 7.3 <input type="checkbox"/> |

8 Housing Density Type (Record in section 1)

Table 2. WUI Types classified by structure separation distance (SSD) and typical parcel size.

| Type # | WUI Type Name | SSD (ft) | Typical Parcel Size (ac) | Typical Housing Density (struct/ac) |
|--------|--|----------------------|--------------------------|-------------------------------------|
| 1 | High Density Interface – Perimeter | 6 ^a to 30 | < 0.5 | 2 to 8 + |
| 2 | High Density Interface – Interior ^b | 6 ^a to 30 | < 0.5 | 2 to 8 + |
| 3 | Medium Density Interface – Perimeter | 30 to 100 | 0.5 to 1+ | < 2 |
| 4 | Medium Density Interface – Interior ^b | 30 to 100 | 0.5 to 1+ | < 2 |
| 5 | Medium Density Intermix | 30 to 100 | 0.5 to 1+ | < 2 |
| 6 | Low Density Interface | 100+ | 1+ | < 1 |
| 7 | Low Density Intermix | 100+ | 1+ | < 1 |

For SI: 1 ft = 0.305 m, 1 ac = 0.4 ha
^a representative of parcels with a 3 ft setback (common for new construction of sprinklered residences)
^b interior of community defined as > 0.25 mi (400 m) from wildlands

Natl. Inst. Stand. Technol. Tech. Note 2205, page 8, Table 2 (March 2022)

Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

9) Vegetation Management –

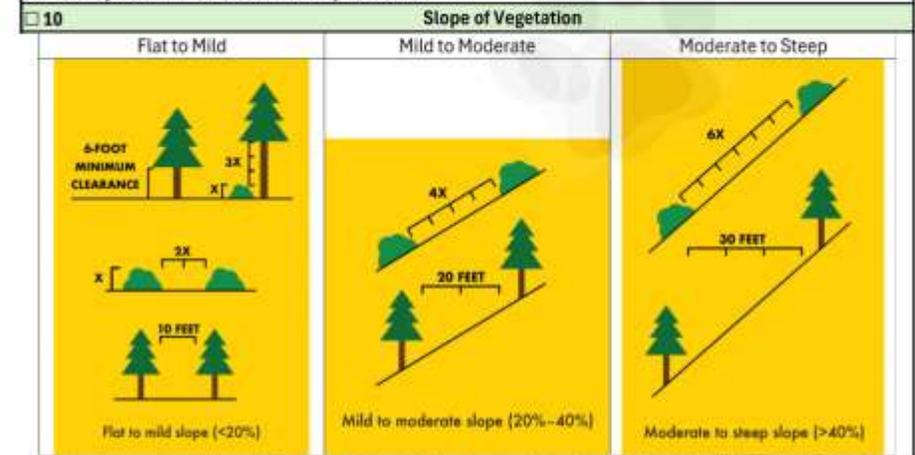
- California Fire Code Chapter 49 Section 4906

10) Slope of Vegetation – The Minimum Fuel Separation Distance if the slope of concern is between wildland fuels & structures (Applies to *Intermix* and *Perimeter*).

- Flat to mild slope $<20^\circ = 100\text{ft}$
- Mild to moderate slope $20^\circ\text{-}40^\circ = 150\text{ft}$
- Moderate to steep slope $>40^\circ = 200\text{ft}$

| 9 C.F.C. Chapter 49 Section 4906 - Vegetation Management | | Mitigate? |
|--|--|--|
| <input type="checkbox"/> 9.1 | Is there an existing landscape plan? (If yes, include it at the end of this assessment) | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 9.2 | Shrubs shall not exceed 6 ft in height. If yes, describe below. | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 9.3 | Groupings of shrubs are limited to aggregate diameter of 10 ft. | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 9.4 | Shrub groupings shall be separated from other groupings a minimum of 15 ft. | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 9.5 | Shrub groupings shall be separated from structures a minimum of 30 ft. | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 9.6 | Where shrubs are located below or within a tree's drip line, the lowest tree branch shall be a minimum of 3x the height of the understory shrubs or 10 ft, whichever is greater. | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 9.7 | New trees that are fire resistant shall be planted and maintained so that the tree's drip line at maturity is a minimum of 10 ft from any structure. | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 9.8 | The horizontal distance between crowns of new trees and crowns of adjacent trees shall not be less than 10 ft. | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 9.9 | Existing trees shall be trimmed to provide a minimum separation of 10 ft away from chimney and stovepipe outlets. | <input type="checkbox"/> Yes <input type="checkbox"/> No |

***Note: New trees not classified as fire-resistant vegetation, such as conifers, palms, pepper trees and eucalyptus species, shall be permitted provided the tree is planted and maintained so that the tree's drip line at maturity is a minimum 30 ft from any structure.**



<https://www.paperform-view.com/cal-fire-communications/cal-fire-ready-set-go-brochure-final-files-v4-print?pd=MjU2324278p=11&v=2%3F>

- 10.1 Select which slopes are found on this parcel. <20 deg. 20 - 40 deg. >40 deg.
- 10.2 Select which slopes are found adjacent to this parcel. <20 deg. 20 - 40 deg. >40 deg.
- 10.3 Minimum Fuel Separation Distance if slope of concern is between wildland fuels & structures. (Applies to *Perimeter* and *Intermix* settings. See "Housing Density Type" chart in section 8.)
- Flat to mild slope (<20 degrees) = **100ft**
 - Mild to moderate slope (20 - 40 degrees) = **150ft**
 - Moderate to steep slope (>40 degrees) = **200ft**
 - Does not apply

Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

11) Defensible Space

- Zone 0: 0 – 5ft from structures
- Zone 1: 5ft – 30ft from structures
- Zone 2: 30ft – 100ft from structures

| 11 Defensible Space | |
|--|-----------------------------|
| <input type="checkbox"/> 11.1 Zone 0: 0 - 5 ft from structures (include supporting images). *No stacked firewood, vegetation, vehicles, wood fences, bbq, smoker, or any other combustible fuels. | |
| Items assessed: | Mitigation recommendations: |
| <input type="checkbox"/> 11.2 Zone 1: 5 ft - 30 ft from structure (include supporting images) | |
| 5ft-10ft: Small vegetation, propane tanks up to 125 gallons per C.F.C. Chapter 61 Section 6104.3. | |
| 10ft-25ft: Propane tanks between 126 - 500 gallons per C.F.C Chapter 61 Section 6104.3, existing trees trimmed at least 10ft away from chimney and stovepipe outlets, new trees that are fire-resistant, and when the trees drip line at maturity is at least 10ft away. | |
| 25ft-30ft: Propane tanks between 501 - 2,000 gallons per C.F.C Chapter 61 Section 6104.3. | |
| * Combustible fuels such as firewood, RV's, boats, sheds, gazebos, or shrub groupings, shall be relocated into Zone 2. If the following combustible fuels cannot be relocated in Zone 2, than removal or structure hardening is required. See section 13 for details. | |
| Items assessed: | Mitigation recommendations: |
| <input type="checkbox"/> 11.3 Zone 2: 30 ft - 100 ft from structure if applicable (include supporting images). | |
| 30ft-50ft: Firewood, shrub groupings, and new trees not fire resistant; dripline at maturity. | |
| 50ft-100ft: ADU's, sheds, structures, RV's, boats, gazebo, propane tanks between 2,001 - 30,000 gallon per C.F.C. Chapter 61 Section 6104.3. | |
| * If the above combustible fuels cannot be relocated into Zone 2, removal or structure hardening is required. See section 13 for details. | |
| Items assessed: | Mitigation recommendations: |

Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

12) Fire & Ember Hardening

- Class 1, 2, or 3 Ignition-Resistant Construction (Chapter 5 of 2024 IWUIC)
- State Fire Marshal Building Material Listing link
- Start top down on each structure
 - Roof Assembly
 - Roof Skylights
 - Solar Panels
 - All Vents
- Energy Efficiency (EE)

| | | |
|---|---|--|
| <input type="checkbox"/> 12 | Fire & Ember Hardening (Includes Direct Flame Exposure, Radiant Heat & Convection) | |
| (Select between Class 1, 2 or 3 Ignition-Resistant Construction based on sections 12.1 - 12.4) | | |
| <input type="checkbox"/> 12.1 | Class 1 Ignition-Resistant Construction (IWUIC Chapter 5) | |
| The primary structure, neighboring structure & auxiliary structure separation distance is < 30ft or for extreme hazards located in FHSZ. | | |
| <input type="checkbox"/> 12.2 | Class 2 Ignition-Resistant Construction (IWUIC Chapter 5) | |
| The primary & auxiliary structure separation distance is between 30ft - 50ft for high hazards located in FHSZ. | | |
| <input type="checkbox"/> 12.3 | Class 3 Ignition-Resistant Construction (IWUIC Chapter 5) | |
| The primary & auxiliary structure separation distance is between 50ft - 100ft for moderate hazards located in FHSZ. | | |
| <input type="checkbox"/> 12.4 | Class 1 Ignition-Resistant Construction (IWUIC Chapter 5) | |
| The primary & auxiliary structure does not meet the Minimum Fuel Separation Distance (MFSD) between untreated wildland fuels & structures, based on topography (Natl. Inst. Stand. Technol. Tech. Note 2205, Table B, Page 62, March 2022) | | |
| <input type="checkbox"/> | Flat to mild slope (<20 degrees) = | 100ft |
| <input type="checkbox"/> | Mild to moderate slope (20 - 40 degrees) = | 150ft |
| <input type="checkbox"/> | Moderate to steep slope (>40 degrees) = | 200ft |
| <input type="checkbox"/> | Does not apply | |
| State Fire Marshal resource: https://calfire.gov/motus.org/BMLSearch/Index | | |
| Fire & Ember Hardening (Start top down) | | Mitigate? |
| <input type="checkbox"/> EE12.5 | Roof Assembly: | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> Class 1: Class A rated roof, space at the eave ends shall be firestopped or have one layer of 72lb mineral-surfaced nonperforated cap sheet complying, repair damages, plug openings with non-combustible materials, seal gaps, roof valley flashing 26ga. galvanized and corrosion resistant 36-inches wide the entire length over one layer of 72lb mineral-surfaced nonperforated cap sheet, flashing over fascia and thermal barrier under flashing (optional: install a thermal barrier such as stone wool board and ignition-resistant roof tile batten). <input type="checkbox"/> Class 2: Class A rated roof, space at the eave ends shall be firestopped or have one layer of cap sheet complying with ASTM D3909, repair damages, plug openings with non-combustible materials, seal gaps, roof valley flashing 26ga. galvanized and corrosion resistant 36-inches wide the entire length over one layer of 72lb mineral-surfaced nonperforated cap sheet, flashing over fascia and thermal barrier under flashing (optional: install a thermal barrier such as stone wool board and ignition-resistant roof tile batten). <input type="checkbox"/> Class 3: Same as Class 2. (Class B roof covering, IWUIC section 506.2, prohibited in CA). | | |
| <input type="checkbox"/> 12.6 | Roof Skylights: | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> Install tempered glass outer pane <input type="checkbox"/> Install metal screen if the skylight opens <input type="checkbox"/> Metal flashing <input type="checkbox"/> No exposed wood. | | |
| <input type="checkbox"/> 12.7 | Solar Panels: | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> Install 1/8 inch corrosion resistant screen mesh to prevent debris accumulation under the solar panels. | | |
| <input type="checkbox"/> 12.8 | All vents (including makeup air intake): | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> Ventilation openings shall be fully covered with vents that have been tested in accordance with ASTM E2886. Ventilation openings shall not exceed 144 square inches each. Vents shall be covered with noncombustible corrosion resistant mesh with openings between 1/16 - 1/8 of an inch. <input type="checkbox"/> Class 1: Attic ventilation openings shall not be located in soffits, in eave overhangs, between rafters at eaves or in other overhang areas. Gable-end and dormer vents shall be located not less than 10 feet from lot lines. Underfloor ventilation openings shall be located as close to grade as practical. Consider vents with intumescent material and louvers. Dryer vents shall have a metal flapper with no screen. Seal any gaps with fire-rated exterior caulking. <input type="checkbox"/> Class 2: Same as Class 1. | | |

Building Materials Listings - Search Listing Services:

Select one Search Category at a time and then click Search button to display the listing.

Category: 8165 -- VENTS FOR WILDLAND URBAN INTERFACE (W.U.I.) ▾
Sort Categories by: Name Number

Company: --- All Listings --- ▾
Sort Companies by: Name Number

Listing: --- All Listings --- ▾
Sort Listings By: Name Number

| Listing Number | Listing Information |
|--------------------------------|--|
| 8165-2192:0500 | Company: Vulcan Technologies Address: 8 Commercial Blvd, Suite E, Novato, CA 94949 Contact: Larry Dumm Phone: (916) 626-2400 Fax: (916) 647-0477 Date Issued: 07/01/2022 Listing Expires: 06/30/2023 Description: Models VER2, VER2M, VER3, VER3M, VER4, VER4M, and VER6M Vulcan Eave Round Vents. Category: VENTS FOR WILDLAND URBAN INTERFACE (W.U.I.) See Listing Service |
| 8165-2192:0501 | Company: Vulcan Technologies Address: 8 Commercial Blvd, Suite E, Novato, CA 94949 Contact: Larry Dumm Phone: (916) 626-2400 Fax: (916) 647-0477 Date Issued: 07/01/2022 Listing Expires: 06/30/2023 |

How to Locate Fire Resistant Building Materials

Office of the State Fire Marshal (OSFM)

- Building Materials Listings (BML)
- In early 2021, a technical group was created to review & compile data for this WUI handbook.
- <https://osfm.fire.ca.gov>

Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

12) Fire & Ember Hardening (Continued)

- Start top down on each structure
 - Unvented Attics
 - Gutters and Downspouts
 - Eaves and Soffits
 - Exterior Wall Siding
 - Windows
 - Exterior Doors
- Energy Efficiency

| | | |
|---|--|--|
| <input type="checkbox"/> Class 3: Attic ventilation may be installed in soffits, in eave overhangs, between rafters at eaves or in other overhang areas. | | |
| <input type="checkbox"/> EE12.9 Unvented Attics (C.B.C. T24 Section 1202.3): | <input type="checkbox"/> Consider for SSD <30ft. | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> 12.10 Gutters and Downspouts: | | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| For all classes of ignition-resistant construction. <input type="checkbox"/> Install metal gutters and downspouts <input type="checkbox"/> Metal gutter guards <input type="checkbox"/> Metal flashing over fascia <input type="checkbox"/> Thermal barrier under flashing <input type="checkbox"/> Seal gaps. | | |
| <input type="checkbox"/> 12.11 Eaves and Soffits: | | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> Class 1: Protect exposed underside with 1hr fire-rated ignition resistant or noncombustible materials directly over exposed wood. Consider enclosing the eaves with noncombustible materials. Attic ventilation openings shall not be located in soffits, eave overhangs, between rafters at eaves or in other overhang areas (IWUIC section 504.10.3). Seal gaps with exterior fire-rated caulking. Consider unvented attic designs per C.B.C. T24 section 1202.3. <input type="checkbox"/> Class 2: Protect exposed underside with 1hr fire-rated ignition resistant or noncombustible materials directly over exposed wood. Exposed rafter tails shall not be permitted unless constructed of heavy timber materials (IWUIC section 505.3). Attic ventilation openings shall not be located in soffits, eave overhangs, between rafters at eaves or in other overhang areas (IWUIC section 505.10.3). Seal gaps with exterior fire-rated caulking. <input type="checkbox"/> Class 3: Protect exposed underside with 1hr fire-rated ignition resistant or noncombustible materials directly over exposed wood. Exposed rafter tails shall not be permitted unless constructed of heavy timber materials (IWUIC section 505.3). Attic ventilation openings are permitted at the eave or soffit using fire and ember rated vents complying with ASTM E2886. | | |
| <input type="checkbox"/> EE12.12 Exterior Wall Siding: | | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> Class 1: Constructed with non-combustible or 1hr fire-rated materials. Consider a 2hr fire-rated wall assembly when SSD is <30ft. Install 6-inch metal flashing at the ground, decking & roof intersections. Install thermal barrier between metal siding or flashing to wood sheathing. Seal any gaps with fire-rated exterior caulking. <input type="checkbox"/> Class 2: Constructed with one of the following methods: <input type="checkbox"/> Materials approved for not less than 1hr fire-rated construction. <input type="checkbox"/> Approved noncombustible materials. <input type="checkbox"/> Heavy timber or log wall construction. <input type="checkbox"/> Fire-retardant treated wood labeled for exterior use. <input type="checkbox"/> Ignition-resistant materials. Complying with section 503.2 on the exterior side extending from the top of the foundation to the underside of the roof sheathing. Seal any gaps with fire-rated exterior caulking. <input type="checkbox"/> Class 3: Same as Class 2. | | |
| <input type="checkbox"/> EE12.13 Windows: | | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> Class 1: IWUIC section 504.8 "Exterior windows, window walls and glazed doors, windows within exterior doors, and skylights shall be tempered glass, multilayered glazed panels, glass block or have a fire protection rating of not less than 20 minutes." Consider 1hr+ fire-rated metal framed windows when SSD <30ft or fire-rated operable shutters over existing windows or windows with only a 20 minute fire-rating. Install metal screens on operable windows. Install a thermal barrier between metal framed windows and wood framing. <input type="checkbox"/> Class 2: IWUIC section 505.8 "Exterior windows, window walls and glazed doors, windows within exterior doors, and skylights shall be tempered glass, multilayered glazed panels, glass block or have a fire protection rating of not less than 20 minutes." Consider installing fire-rated operable shutters over existing windows or windows with only a 20-minute fire-rating when SSD is between 30ft-50ft. <input type="checkbox"/> Class 3: Exterior windows, window walls and glazed doors, windows within exterior doors, and skylights shall be tempered glass, multilayered glazed panels, glass block or have a fire protection rating of not less than 20 minutes. | | |
| <input type="checkbox"/> EE12.14 Exterior Doors: | | <input type="checkbox"/> Yes <input type="checkbox"/> No |
| <input type="checkbox"/> Class 1: Exterior doors shall be approved noncombustible construction or have a fire-rating of not less than 1-hour. Install noncombustible threshold and door jamb. Install fire, ember and smoke rated weather stripping. If the door jamb is metal, install a thermal barrier between the metal and wood framing to prevent each transfer, | | |

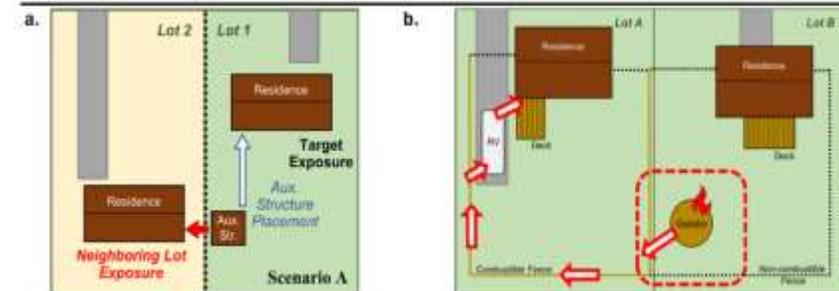
Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

12) Fire & Ember Hardening (Continued)

- Start top down on each structure
 - Exterior Screen Doors
 - Garage Doors
 - Skirting
 - Decks, Stairs and Landings Attached to Residence
 - Deck-to-Wall Intersections
 - Fence-to-Residence
 - Retaining Walls
 - Combustible Furniture
 - Other Penetrations
- Illustrations
 - a. Auxiliary Structure Exposure
 - b. Fire Ladder

| | | |
|---|---|--|
| especially at the hinges. Seal gaps with fire-rated exterior caulking. <input type="checkbox"/> Class 2: Exterior doors shall be approved noncombustible construction, solid-core wood not less than 1 3/4 inches thick (45mm), or have a fire-rating of not less than 20 minutes. Windows within doors and glazed doors shall be tempered, multiglazed panels, glass block or have a fire-rating of not less than 20 minutes. Install fire, ember and smoke rated weather stripping. Seal gaps with fire-rated exterior caulking. <input type="checkbox"/> Class 3: Same as Class 2. | | |
| <input type="checkbox"/> 12.15 Exterior Screen Doors: | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <input type="checkbox"/> Replace wood screen doors with metal screen door with metal mesh screen material. | | |
| <input type="checkbox"/> 12.16 Garage Doors: | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <input type="checkbox"/> Exterior garage doors shall resist the intrusion of embers from entering by preventing gaps between doors and door openings, at the bottom, sides and tops of doors, from exceeding 1/8 inch (3.2mm). If the garage door is not metal, install 6 inch metal flashing around the bottom of the door inside and out, within 1/8 inch of the ground, and add fire-rated-gasketing around the garage door. | | |
| <input type="checkbox"/> 12.17 Skirting: | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <input type="checkbox"/> Install non-combustible or 1hr fire-rated skirting on all sides of spaces under all structures on the parcel. | | |
| <input type="checkbox"/> 12.18 Decks, stairs and landings attached to residence: | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| For all classes of ignition-resistant construction: <input type="checkbox"/> Replace combustible materials with non-combustible or 1hr fire-rated material, and <input type="checkbox"/> the area under the deck, stairs or landing must be maintained with no combustible materials. <input type="checkbox"/> Install metal flashing between deck boards at joists. | | |
| <input type="checkbox"/> 12.19 Deck-to-wall intersection: | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <input type="checkbox"/> Replace combustible siding with non-combustible or 1hr fire-rated siding and <input type="checkbox"/> install metal flashing with a thermal barrier such as fiber cement board to prevent heat transfer to protect exposed sheathing. | | |
| <input type="checkbox"/> 12.20 Fence-to-residence: | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <input type="checkbox"/> Replace wood fence with metal/non-combustible option. <input type="checkbox"/> Consider installing a block wall when SSD is <30ft. | | |
| <input type="checkbox"/> 12.21 Retaining Walls: | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <input type="checkbox"/> Replace retaining wall length equal to two times retaining wall height with non-combustible material. | | |
| <input type="checkbox"/> 12.22 Combustible Furniture: | <input type="checkbox"/> Yes | <input type="checkbox"/> No |
| <input type="checkbox"/> Replace furniture with non-combustible furniture <input type="checkbox"/> move to Zone 1 <input type="checkbox"/> place cushions indoors when not in use. | | |
| <input type="checkbox"/> 12.23 Other Penetrations: | <input type="checkbox"/> Seal around penetrations with exterior fire-rated caulking | <input type="checkbox"/> Yes <input type="checkbox"/> No |

Notes:



a. Auxiliary structure exposure b. fire ladder

Parcel Assessment for Wildfire Hardening (PAWH) form - Sections

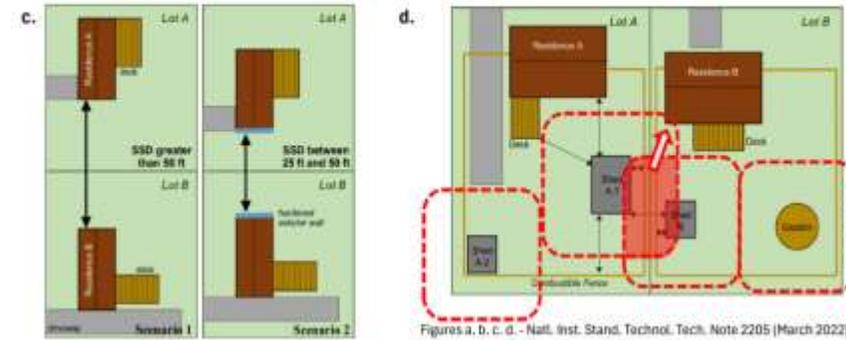
12) Fire & Ember Hardening (Continued)

- Illustrations

- c. Harden the side of the structure exposed
- d. Fuel agglomeration

13) Overview of Recommendations

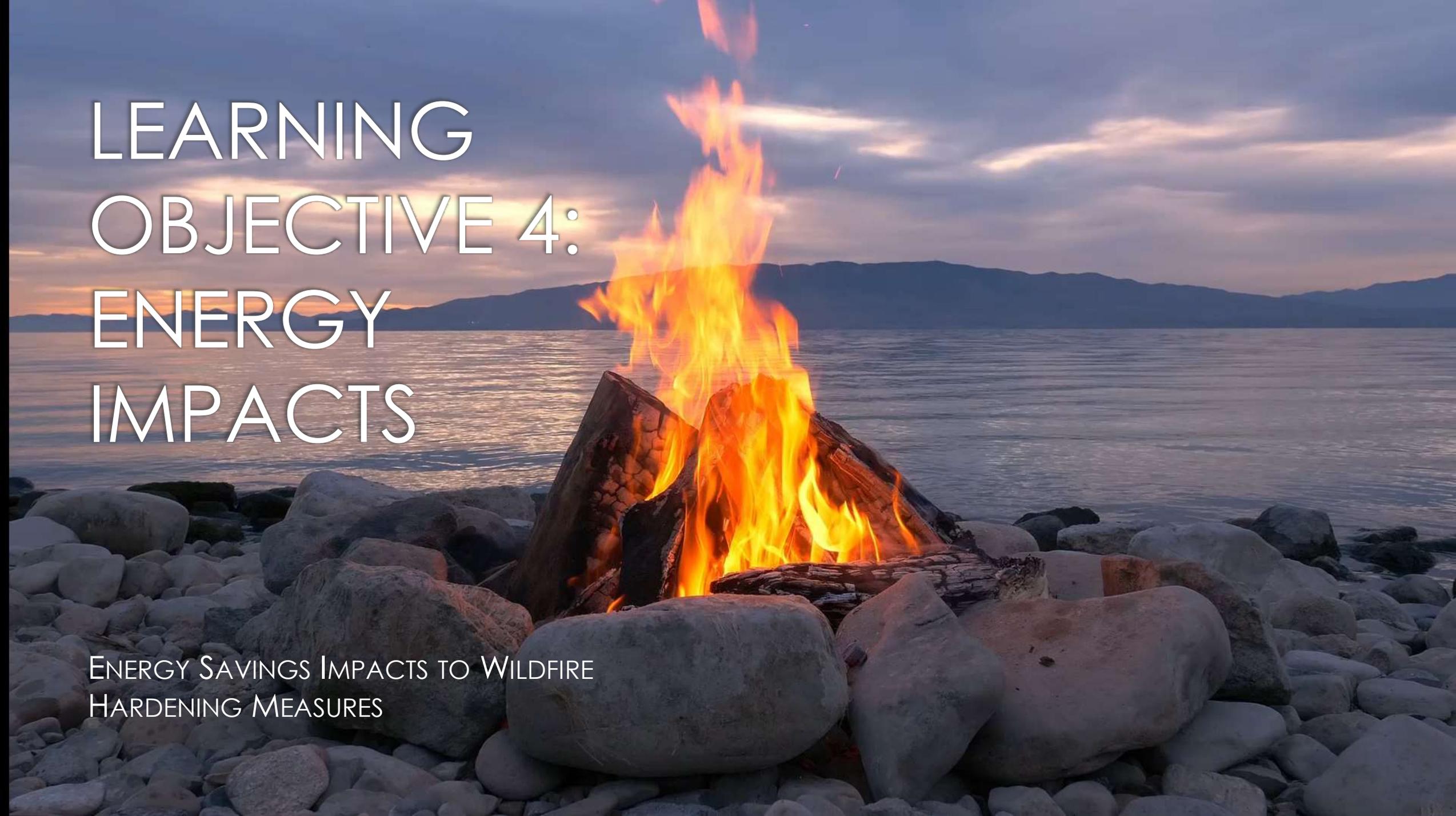
- Insert an image or draw an illustration with recommendations or requirements



Figures a, b, c, d. - Natl. Inst. Stand. Technol. Tech. Note 2205 (March 2022)

c. harden the side of the structure exposed d. fuel agglomeration



A campfire with bright orange and yellow flames is burning on a rocky beach. The fire is built on a pile of logs. In the background, there is a calm body of water reflecting the sunset sky, which is filled with soft, colorful clouds. Distant mountains are visible on the horizon under a twilight sky.

LEARNING OBJECTIVE 4: ENERGY IMPACTS

ENERGY SAVINGS IMPACTS TO WILDFIRE
HARDENING MEASURES

PURPOSE



To investigate the effects and hurdles that hardening structures has on energy efficiency and compliance.



Identify cost variables to implement select Fire-Rated (FR) technologies into residential structures and gain an understanding of the cost sensitivity.

PROCEDURE

- Two residential energy model templates were used. A single story and a two-story structure.
- CBECC templates were used which have the two standardized models which successfully demonstrate passing T-24 compliance (2022 T-24 Standards).
- Added to the models were the following technologies:
 - Fire rated (FR) fenestration
 - FR exterior doors
 - Upgraded high-performance U-stucco siding



RESULTS – SINGLE STORY COSTS

- FR technologies caused the model to fail (narrowly) T-24 compliance.
- The additional electrical energy costs are estimated to be \$69 annually.
- The marginal cost to implement the FR technologies is:
 - \$73,700 for glazing upgrade
 - \$1364 for upgrading to a 90-minute FR rated external entry door
 - \$1,528 for U-stucco upgrade



Results – 2 Story Costs

- The implementation of the FR technologies caused the model to fail (narrowly) T-24 compliance.
- The additional electrical energy costs are estimated to be \$118 annually.
- The marginal cost to implement the FR technologies is:
 - \$71,100 for glazing upgrade
 - \$1364 for upgrading to a 90-minute FR rated external entry door
 - \$3,058 for U-stucco upgrade

Discussion – T24 Energy Compliance Issues

- Typically, FR windows do not have NFRC ratings. Per T-24 requirements, a default value for the windows are required which handicapped the energy model performance.
- T-24 Mandatory measures for fenestration U-values have changed which previously caused a hurdle for FR windows.
- New changes (exceptions) in the T-24 Energy Code now address FR fenestration for WUI areas as a safety issue covered in Chapter 7A.





✦ Mandatory Measure Updates

- ✧ **Fenestration (including skylights)** that separate conditioned space from unconditioned space or outdoors shall have **maximum weighted average U-factor of 0.40**

Changed from 0.45

✧ Exceptions:

- ◆ Up to **10 ft²** of fenestration area (or **0.5%** of conditioned floor area), whichever is greater
- ◆ Up to **30 ft²** of dual-glazed greenhouse or garden windows
- ◆ Fenestration installed to meet Part 7 of CA Building Code in buildings located in **Fire Hazard Severity Zones** or **Wildland-Urban Interface (WUI) Fire Areas**

New



Discussion – U-Stucco Costs



- U-Stucco provides an additional building envelope insulation benefit: + R-value of 1.6 over standard 3-coat stucco.
- Helps offset the performance penalty assigned by T-24 to the non-NFRC rated FR glazing's.
- U-Stucco is noncombustible. It does not emit toxic gas or sustain flame when exposed to fire; can resist 3,000 F for over 3 hours.
- U-Stucco estimated installation cost differential: Approx. \$1.50/ sqft retail.
- 1-story comparison:
 - Total Cost differential: \$1,528 [1019 sqft]
- 2-story comparison:
 - Total Cost differential: \$3,058 [2039 sqft]

Discussion – FR Glazing Costs

- High performance FR glazing's costs are significantly higher than conventional high-energy performance glazing.
 - 1-story comparison:
 - High-energy performance glazing estimated installation costs: \$11,646
 - FR upgraded high-performance glazing costs: \$85,375
 - Cost differential: \$73,728
 - 2-story comparison:
 - High-energy performance glazing estimated installation costs: \$11,840
 - FR upgraded high-performance glazing costs: \$82,955
 - Cost differential: \$71,114

Discussion – FR Door Costs

- 90-minute FR rated exterior entry doors replace the common entry doors (20-minutes).
- 1-story and 2-story models
 - 20-minute door cost: \$244
 - 90-minute door cost: \$1,608
 - Cost variance: \$1,364



Lessons Learned

- FR fenestration presents a challenge to T-24 compliance. Expect a modeling penalty in U-value which will need to be compensated for in other measures such as increased exterior insulation.
- The Energy Code exception is silent on what fenestration U-value is to be used for modeling. Check with your Building Officials on what they will accept during the design process. Get this acceptance in writing!
- The Fire Code appears to require ALL fenestration is subject to WUI areas will need to be FR rated. Expect this to increase building costs significantly. Check with your Building Officials on what they will accept during the design process.
 - Tempered – Section 2406, or
 - Glass block, or
 - FR rating of at least 20 minutes; NFPA 257, or
 - Tested per SFM 12-7A-2
- FR windows are typically not made for very large window areas. Check with your manufacturer on what sizes they can provide during design. The robust frame may also impact the size and location of FR window application.

Learning Objective 5: Key Points and Final Thoughts

- **100% ember hardening compliance is required**
 - All homes located in Fire Hazard Severity Zones and the Wildland-Urban Interface
- **Successful hardening against direct flame, radiant heat and convection includes:**
 - Non-combustible materials used in high-density settings (<30')
 - No metal to wood (thermal bridging to combustible materials)
 - Install thermal barriers between metal and wood
 - Enclose the eaves as they trap heat (w/non-combustible materials)

Key Points

- **Energy Efficiency** gains are realized from:
 - Air sealing
 - Proper sealing around fire-rated doors and windows
 - Advanced framing
 - Non-combustible or ignition-resistant thermal barriers added to:
 - Roof decks
 - Exterior insulated sheathing/siding

Key Points

- Vinyl window frames have been observed melting and failing from a residential fire 50ft away.
- **Consider:**
 - **Using 60-120min. fire-rated steel framed windows only on the sides of the structure that are exposed to high fuel loads.**
 - **Installing fire-rated operable shutters over existing or new vinyl framed windows.**

Key Points

- **2025 California Wildland-Urban Interface Code (Effective January 1, 2026)**
 - Section 503.1 General states, “Buildings and structures...shall meet the construction requirements in accordance with Chapter 5.”
 - Exceptions, “Additions to and remodels of buildings originally constructed prior to July 1, 2008.”
 - Demonstrates the importance of hardening both the structures and parcel, not only from wildfires, but from neighboring parcels and structures that are not hardened against wildfires.



Q&A

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