

Windows and Skylights



FEMA

Purpose

To provide information about measures that can be taken to avoid the ignition of interior building components and contents due to the intrusion of windborne embers, hot gases, and radiant heat through windows, sliding glass doors, door vision panels, and skylights. Guidance pertains to both new and existing buildings.

Key Issues

- Glazing in homes is typically vulnerable to wildfire (see Figure 1). ("Glazing" refers to the glass, plastic, or fiberglass-reinforced translucent material in windows, sliding glass doors, door vision panels, and skylights.) Failed glazing allows easy passage of embers, hot gases, and radiant heat into the interior of the building. Glazing is vulnerable to wildfire in two ways:
 - Flame impingement and radiant heat can be severe enough to melt or break many types of glazing. A single pane of typical residential glass can fail within 5 minutes of exposure to a wildfire (Slack, 2000).
 - Windborne firebrands can have sufficient momentum to break many types of glazing.
- The frames for windows, sliding glass doors, and skylights are constructed of metal, plastic, wood, or a combination of these materials. Plastic and wooden frames are susceptible to failure from burning or melting (see Figure 2). If the frame or sash fails, the entire glazing may fall out.

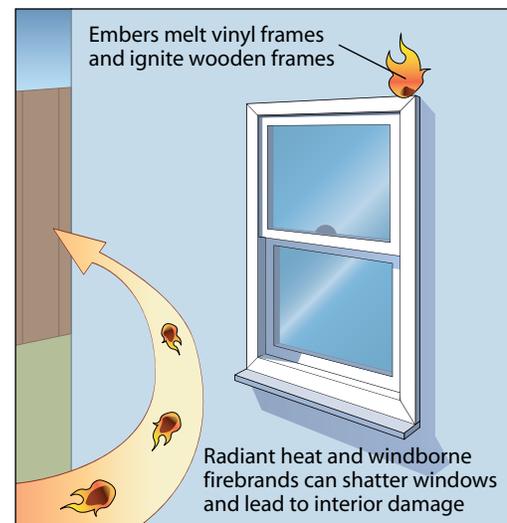


Figure 1. Potential damage to a window during a wildfire.



Figure 2. Combustible framing (firecenter. berkeley.edu).

Guidance on New Buildings

This section provides guidance on glazing, frames, fire-rated assemblies, and exterior window shutters.

Glazing

A variety of products are available for glazing in windows, sliding glass doors, door vision panels, and skylights. Glazing can be in a single- or multi-paned configuration. The recommended glazing products for homes in wildfire zones are laminated glass, tempered glass, glass with a low-emissivity, fiberglass-reinforced translucent glazing, and insulated glazing units (IGUs). Glazing products that are not recommended are annealed glass, ceramic glass, and plastic glazing.

Recommended

- **Laminated glass.** Laminated glass provides resistance to windborne firebrands. If a firebrand strikes with enough momentum to break the glass, the plastic film in the core of the glass will keep the glazing in the frame, allowing the broken glass to continue to resist firebrand impacts, embers, and hot gases. If the plastic film in the core gets sufficiently hot, the pane will delaminate whether or not the glass has been broken. If laminated glass is specified, it should either be protected by shutters, as discussed below, or combined with tempered glass in an IGU. See the information on IGUs below.
- **Tempered glass.** Tempered glass is more resistant to heat and flames than laminated glass or annealed glass (see below). The resistance of tempered glass can be enhanced with a low-e coating or a proprietary reflective coating, as discussed below. Firebrands with sufficient momentum can break tempered glass. To avoid breakage, the glass can be protected by shutters, as discussed below. Another alternative is to specify and install an IGU with a laminated glass inner pane.
- **Low-emissivity (low-e) coating.** Glass with a low-e coating provides a higher level of resistance to radiant heat than other types of glazing because the coating reflects radiant heat, reducing the probability that the heat will be able to enter the building. The coating should be on the inner surface of the exterior pane.
- **Proprietary fiberglass-reinforced translucent glazing.** This product is available for skylights and walls. The skylight material has a Class A rating. See Fact Sheet #5, Roofs, for a discussion of this type of rating.
- **Insulated glazing unit.** An IGU consists of two or three panes of glass that are separated by a sealed air space. Double-paned annealed units last about 10 minutes in a wildfire, twice as long as single-paned windows. In many cases, 10 minutes is long enough to provide protection from the fire. If the first pane fails, the second pane must still be penetrated (Slack, 2000) (see Figure 3). Laminated glass, tempered glass, and glass with a low-e coating can be combined in various ways into an IGU.

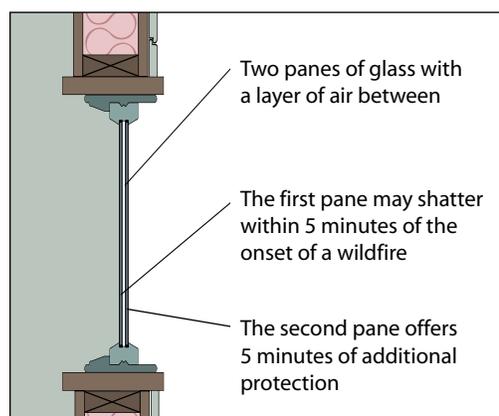


Figure 3. Double-paned glazing.

Not Recommended

- **Annealed glass.** Annealed glass (also known as common float glass) is commonly used in residential windows. Annealed glass is the most susceptible to wildfires of the various glass types and is not recommended for homes in wildfire zones unless protected by shutters, as discussed below.
- **Ceramic glass.** This specialty glass is effective at resisting flames, but it transmits radiant heat readily. If ceramic glass is used for exterior glazing, heat that is high enough to cause ignition can be transmitted into the interior of the building. Ceramic glass is not recommended for homes in wildfire zones.
- **Plastic glazing.** Acrylic and polycarbonate are often used in skylights and sometimes in windows. Because plastic glazing can melt during a wildfire, it is not recommended for homes in wildfire zones.

Frames

A variety of products are available for window and skylight frames. To avoid window failure, frames should be constructed only of metal or metal-clad wood. Wooden and plastic frames should not be used.

Fire-rated Assemblies

If a fire-rated wall is specified, windows and sliding glass doors that are commensurate with the wall in terms of the fire rating are recommended. For example, a window with a 1½-hour rating is intended to be used in a wall with a 2-hour rating, and a door with a ¾-hour rating is intended to be used in a wall with a 1-hour rating. However, a window with a higher fire rating may be used. See Fact Sheet #7, Exterior Walls, for information about fire-rated walls.

If a fire-rated wall is not specified, an IGU with a metal or metal-clad wooden frame should be used. See the information on IGUs above.

Exterior Window Shutters

Exterior window shutters can provide protection for windows and sliding glass doors in a wildfire. Solid metal shutters are unlikely to ignite or melt and are therefore recommended over wooden or plastic shutters (see Figure 4). For enhanced protection, an insulated metal shutter can be designed and fabricated. If the building is located in a windborne debris region within a hurricane-prone region, the shutter should meet the windborne debris criteria in the American Society of Civil Engineers standard, ASCE 7-05 (2006).



Figure 4. This metal shutter has top and bottom tracks that are permanently anchored to the wall (FEMA 577).

Guidance on Existing Buildings

- Windows and sliding glass doors, including frames, that are susceptible to damage from a wildfire should be replaced with the components that are recommended above and/or protected by shutters, as recommended above.
- Door vision panels that are susceptible to damage from a wildfire should be replaced with tempered glass with a low-e or proprietary reflective coating, provided the door has sufficient fire resistance (see Fact Sheet #11, Exterior Doors).
- Skylights with plastic glazing should be replaced with one of the recommended types of glazing, as described above.

Considerations

- Shutters protect the home not only from wildfires but also from extreme weather.
- Double-paned glass is more energy efficient than single-paned glass.
- A proprietary reflective coating is available for application to tempered glass. The coating acts like a low-e coating in that it reflects radiant heat, but the proprietary reflective coating may be more effective. For more information on this product and a comparison of fire ratings of various types of glass products and sizes, see www.safti.com.

Effectiveness

- Window assemblies with 3/4-hour minimum ratings are effective in all Fire Severity Zones.
- Metal cladding on metal clad-wood frames may become distorted during wildfire exposure and require replacement.
- Temporary shutters are effective only if the homeowner has sufficient time to put the shutters into place.

Resources

American Society of Civil Engineers. (2006). *Minimum Design Loads for Buildings and Other Structures*. ASCE 7-05.

Center for Fire Research and Outreach. University of California, Berkeley: College of Natural Resources. <http://firecenter.berkeley.edu/default.htm>.

Exterior Windows SFM Standard 12-7A-2, 2001 California Referenced Standard Codes (Part 12, Title 24, C.C.R.). http://www.fire.ca.gov/fire_prevention/downloads/Part_12_CA_SFM_12-7A-2_Test_Standards.pdf.

FEMA. 2007. *Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds: Providing Protection to People and Buildings*. Risk Management Series, FEMA 577. <http://www.fema.gov/library/viewRecord.do?id=2739>.

Fire Rated Glazing Solution. www.safti.com.

Slack, P. 2000. *Firewise Construction Design and Materials*. Colorado State Forest Service.