

Reducing fatalities from wildland-urban interface (WUI) fires

Why are WUI fire evacuations difficult?

Fires that originate near or within wildland-urban interface (WUI) communities are now spreading faster than in the past century, putting at risk the life safety of civilians and first responders. There are many challenges to planning and conducting WUI fire notifications and evacuations.

In the US, recent tragic fires in California, Hawaii, and Oregon have highlighted the need for effective and efficient notification and evacuation plans that address these challenges and those brought on by faster spreading fires.

What is a *no-notice* WUI fire/evacuation event?

A [wildfire] incident occurring with little or no warning and requiring rapid assessment, decision making, communication, and implementation of protective action.

—Federal Emergency Management Agency

A no-notice WUI fire is a quickly developing event that affects a community before any notifications can be issued or evacuation can be conducted safely before egress routes may be blocked by fire or heavy smoke.

Where and why do fatalities occur?

Fatalities during a WUI fire can occur in residences or other buildings if people cannot, or decide not to, evacuate. Other fatalities may occur as people are trying to evacuate and they get caught by fire. There are different reasons why these events occur; some examples are listed in the table below.

Fatal Situation	Scenario	Contributing Factor
Trapped in a residence or other building that catches on fire and is destroyed	Impaired and unable to evacuate	No evacuation assistance is available
	Able to evacuate but has no transportation	No assistance or public transportation is available
	Able and has the means to evacuate	Resident decides to stay and defend their property or misinterprets the risks
	Able and has the means to evacuate, but cannot because of fire or heavy smoke	A rapidly developing no-notice event precludes notifications or earlier action
		Emergency notifications were not broadcast or were issued but not received
		Evacuation orders were not followed promptly
		Evacuation was delayed to help other residents or to collect personal items
Trapped in a vehicle during evacuation and getting overrun by fire (burnover)	Evacuating in a vehicle when fire and/or heavy smoke overrun the egress route (burnover). Very high fire and/or smoke exposures can result in fatalities.	Resident is attempting to get out of the fire area or trying to reach a safety zone. This can occur early in the incident during a no-notice event or when gridlocked in traffic from prolonged duration evacuations.

How can fatalities be reduced or avoided during WUI fires?

The most effective way to enhance life safety during WUI Fires, when there is sufficient time to evacuate to safety, is to employ programs to educate and prepare residents to evacuate quickly and as directed by first responders. While early evacuation should be a cornerstone of a community notification/evacuation plan, it is critical to plan for no-notice events and to address all the scenarios and challenges that can result in fatalities.

Challenges to planning and conducting evacuations

1. Large number of possible fire scenarios (ignition location, fuel presence, fuel moisture content, weather).
2. Chaotic behavior, in which small perturbations of variables can result in large changes in predicted event outcomes.
3. Difficulty in characterizing, quantifying, and analyzing the large number of different fire scenarios.
4. Complexities of modeling and predicting human behavior in evacuations and response to emergency situations.
5. Difficulties in how to account for the uncertainties in the methods used to generate the different scenarios.
6. Characterize and quantify the possibility of containment of the fire before impacts to community and evacuations (to address the large number of ignitions that do not result in catastrophic events).
7. Limits in situational awareness, including dynamic outages in data sources and communications.
8. Integration of rapidly changing conditions into ongoing evacuation activities.
9. Large uncertainty in fire spread during incidents.
10. Difficulties in how to use and implement the findings from all these challenges.

Important planning considerations

1. Develop contingencies for events like loss of communication and power.
2. Develop contingencies for potential closures or obstructions of egress arteries.
3. Evaluate evacuation through high-hazard wildland areas (which may result in burnovers), an issue that is particularly important for remote intermix communities.
4. Evaluate evacuation pathways that lead through urban areas for intermix communities adjacent to or near a large urban area.
5. Disseminate the evacuation plans to first responders and the public.
6. Communicate any changes to the evacuation plan to first responders and civilians.

Components of a comprehensive evacuation plan

Evacuation Assistance Programs: These programs can enhance the evacuation of both mobility impaired residents and those without transportation. Programs can be operated by local governments or community-based and supported by neighbors.

Public Education: Informing the public on how rapidly WUI fires can spread in today's conditions and what they should do during a WUI fire will reduce the number of residents that choose to stay behind. This will reduce the potential for fatalities and the need of rescues.

Safe Egress Routes: Reducing potential exposures to evacuees requires fuel treatments and regular maintenance. This may be difficult to achieve everywhere due to large fuels loads, the length of roadways to be treated, and jurisdictional complexities. Targeted fuel reduction will provide enhanced road access at key locations within the community and along evacuation routes.

Fire Shelters: There are currently no standards for the design and maintenance of fire shelters. Even hardened critical buildings like hospitals and fire stations, as they are built today, can burn during WUI fires. Designing and building fire shelters is a complex and expensive task.

Safety Zones and TFRAs: In-depth studies of recent deadly fires have identified a range of fire, ember, and smoke exposures experienced during evacuation. These exposures are categorized into five levels in the table below. The goal of a well-developed notification/evacuation plan is to prevent/limit any exposures experienced during evacuation that are Immediately Dangerous to Life and Health. Temporary Fire Refuge Areas (TFRAs) are open spaces (like existing large parking lots, parks, and sports fields located throughout the community) that can be used as areas of last resort to enhance the life safety of residents. Residents can walk to a TFRA when they do not have sufficient time to safely reach a Safety Zone or safely leave the fire area. TFRAs are different from Safety Zones. TFRAs should not be used as a substitute for an early evacuation. You can learn more about the new concept of TFRAs by downloading the [TFRA Fact Sheet](#).

TFRA Fact Sheet



Range of exposures that may be experienced during evacuation

Scale	Exposure Level 0	Exposure Level 1	Exposure Level 2	Exposure Level 3	Exposure Level 4
	SAFE	SAFE	UNHEALTHY	VERY DANGEROUS	IMMEDIATELY DANGEROUS TO LIFE OR HEALTH
Description	Location outside the fire perimeter with no exposure to smoke or fire	Location outside the fire perimeter with high AQI smoke exposure	Location inside fire perimeter with exposures to embers and smoke	Location inside fire with some fire exposures and potential for high exposures to embers and smoke	Overrun by fire (burnover) or trapped in a burning building
Location Type	Unspecified	Unspecified	Safety Zone	Temporary Fire Refuge Area (TFRA)	Burnover/entrapment
Fire Exposure	None	None	None	Low to moderate (up to ~ 2.5 kW/m ²)	High exposures (over ~ 2.5 kW/m ²)
Ember Exposure	None	None	Yes	Yes	Yes
Smoke Exposure	None	Low	Low to moderate	Moderate to heavy	Moderate to heavy
Impacts	None	Sensitive populations may be affected by smoke.	N-95 masks will enhance tenability, particularly in moderate smoke exposure conditions.	N-95 masks will enhance tenability. Radiation may compel relocation within the TFRA during occupation based on surrounding fuels and fire spread. Health hazards from toxic gases may exist.	Life-threatening situation with limited escape options. This exposure level applies both to civilians and first responders in transit and to individuals trapped inside burning buildings.

Note: Fire exposure limits are approximate based on injury to unprotected skin. This table is preliminary and subject to change.
AQI: Air Quality Index

A path forward to a new generation of WUI fire evacuation planning and response

During rapidly developing WUI fires, every minute matters. Simplified yet robust decision-making, practice/training, and an informed and engaged public are essential to the successful execution of an effective notification/evacuation plan. Streamlined decision-making and notification system activation along with an informed public are all essential to enhancing public and first responder safety. NIST's *WUI Fire Evacuation and Sheltering Considerations – Assessment, Planning, and Execution (ESCAPE)* [report](#) and accompanying education/training [website](#) can help local officials enhance their community notification and evacuation plans.



Website

Report