

New fire shelter prototypes could buy time for wildfire firefighters

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Researchers evaluated new designs for wildland fire shelters after field tests.
Credit: Joseph Roise

North Carolina State University researchers found that four new designs for shelters to protect firefighters trapped in wildfires could increase the survival time inside the shelter compared with the current industry standard. In lab simulations of wildfire burn-overs—where a wildfire sweeps over a group of trapped firefighters or equipment—temperatures

inside the shelters remained within survival limits for longer, and the shelters took longer to break open.

Researchers hope their findings from the lab, as well as from [field tests](#) conducted across North America, could spur the development of new, better shelters. In addition, they hope the findings will inform new standards for [shelter](#) design and testing.

"For the wildland firefighter, deploying a shelter is the last thing they want to do—it's the final resort, the last line of defense," said study co-author Roger Barker, the Burlington Distinguished Professor of Textile Technology at NC State and the director of the Textile Protection and Comfort Center (TPACC). "While there's no such thing as 'fire-proof,' what we're trying to do is to buy more time. We were able to demonstrate our shelters could increase the time to failure—time that could be critical for survival."

One problem with the industry standard shelter is that the aluminum outer layer will melt in contact with direct flame.

"In light of the failure mechanisms of shelters that we observed during wildland fires, we thought we could develop better shelters that provide enhanced protection by incorporating an inner heat-blocking barrier and additional thermal insulation into the construction," said the study's lead author Joseph Roise, professor of forestry and environmental resources at NC State. "We know we can make a better shelter."

With that goal in mind, the researchers designed two leading prototypes and two lighter versions weighing less than five pounds. They added insulating materials, and experimented with different seam designs to keep them from falling apart.

In the TPACC lab, researchers tested the designs against the industry

standard in a [test chamber](#) called the PyroDome Turbulent Flame Fire Shelter Test System. They blasted the shelters with direct flame from propane burners for 60 seconds, and measured how long it took the temperature at the floor of the shelters to reach 302 degrees Fahrenheit, the temperature threshold for survival. They also set up cameras inside PyroDome to see when the inner layer of the shelters would break open.

All of the prototypes had improved survival metrics compared to the standard, which reached the survival limit in less than 40 seconds. Meanwhile, the temperature in one of their designs was nowhere near the survival limit temperature at 60 seconds.

The researchers also tested the shelters' performance in variety of conditions in controlled burns in Canada, California, North Carolina and South Dakota. However, they found the field tests were not reliable enough to draw statistically significant conclusions because of wind, fuel and fire conditions.

"We went all over North America to find different fire conditions that would give different types of fire exposures," Barker said. "What we found is there is so much variability in the field test, confirming how useful it was for us to have PyroDome."

The two tests in southern California had the best burn conditions, and researchers saw one of their prototypes performed well in a burn-over. In a test in South Dakota, researchers witnessed shelter failures when grass roots caught fire to spread under the walls inside the shelter. That underscored the importance of fully clearing the area around the shelter, and even scraping down underneath them to remove all organic material.

"If you have a sample of two, you can't make any statistical comparisons," Roise said. "But we did see that after the test in California, one of our best-performing prototypes got the full brunt of

the fire. It was totally burned on the outside, but the inside was undamaged."

The new findings could give manufacturers and people developing these shelters a new target to shoot for in terms of both how to test them and minimal performance requirements, according to Barker.

The study, "Field and full-scale laboratory testing of prototype wildland fire shelters," was published online in the *International Journal of Wildland Fire*.

More information: Joseph Roise et al, Field and full-scale laboratory testing of prototype wildland fire shelters, *International Journal of Wildland Fire* (2022). [DOI: 10.1071/WF21102](https://doi.org/10.1071/WF21102)

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