Fire Tech Tips

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Deploying Your Fire Shelter in a Body of Water

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In July 2007, nine firefighters were overrun by the Seven Oak Fire in California. They sought refuge in a small pond, where they deployed their fire shelters for extra protection. All nine firefighters walked away from this potentially deadly entrapment with relatively minor injuries. Few fire shelter deployments have been documented in water bodies.

The nine firefighters were interviewed by technical specialists from the Missoula Technology and Development Center (MTDC) and CAL FIRE to determine how the fire shelters performed during the entrapment. These interviews raised many questions about deploying fire shelters in a body of water (figure 1).

Highlights...

- During July 2007, nine firefighters deployed fire shelters in a small pond during the Seven Oak Fire in California.
- Deploying a fire shelter in a body of water can expose firefighters to additional safety hazards.
- This tech tip discusses some of the hazards of deploying a fire shelter in water and some of the precautions firefighters should take if they are considering doing so.

Figure 1—Nine firefighters deployed shelters, some before entering the water and some after entering this 60- by 45-foot pond on the Seven Oak Fire.

Many firefighters view ponds, lakes, streams, rivers, swimming pools, hot tubs, or other water bodies as possible safety zones. The National Wildfire Coordinating Group's Fireline Handbook says a safety zone is a preplanned area large enough and in a suitable location where firefighters won't be expected to need fire shelters to protect them from being injured by known hazards. Water bodies can provide some level of protection when a fire burns over firefighters. However, water bodies may present their own safety hazards, which prevent them from meeting the definition of a true safety zone.

Evaluating Water Features

Many considerations must be taken into account before determining whether a body of water is a suitable deployment site. In particular, the water should not be over the firefighter's head. Once clothing and boots become waterlogged, firefighters would find it difficult to stay afloat.

According to the Fireline Handbook, a suitable body of water should be more than 2 feet deep. Dr. Bret Butler from the Forest Service, U.S. Department of Agriculture, Rocky Mountain Research Station says that based on "heating levels characteristic of full-scale crown fire with vegetation immediately adjacent to water body…the minimum depth of water should be 18 inches, deeper is better."

Firefighters have survived entrapments by seeking refuge in water features shallower than 18 inches. Some firefighters have wondered whether they might be burned by steam if they deployed in a shallow water body, but that has never been documented. Firefighters who deployed at the edge of Anderson Creek during the 2005 Little Venus Fire did not observe steam or boiling water (figures 2 and 3).

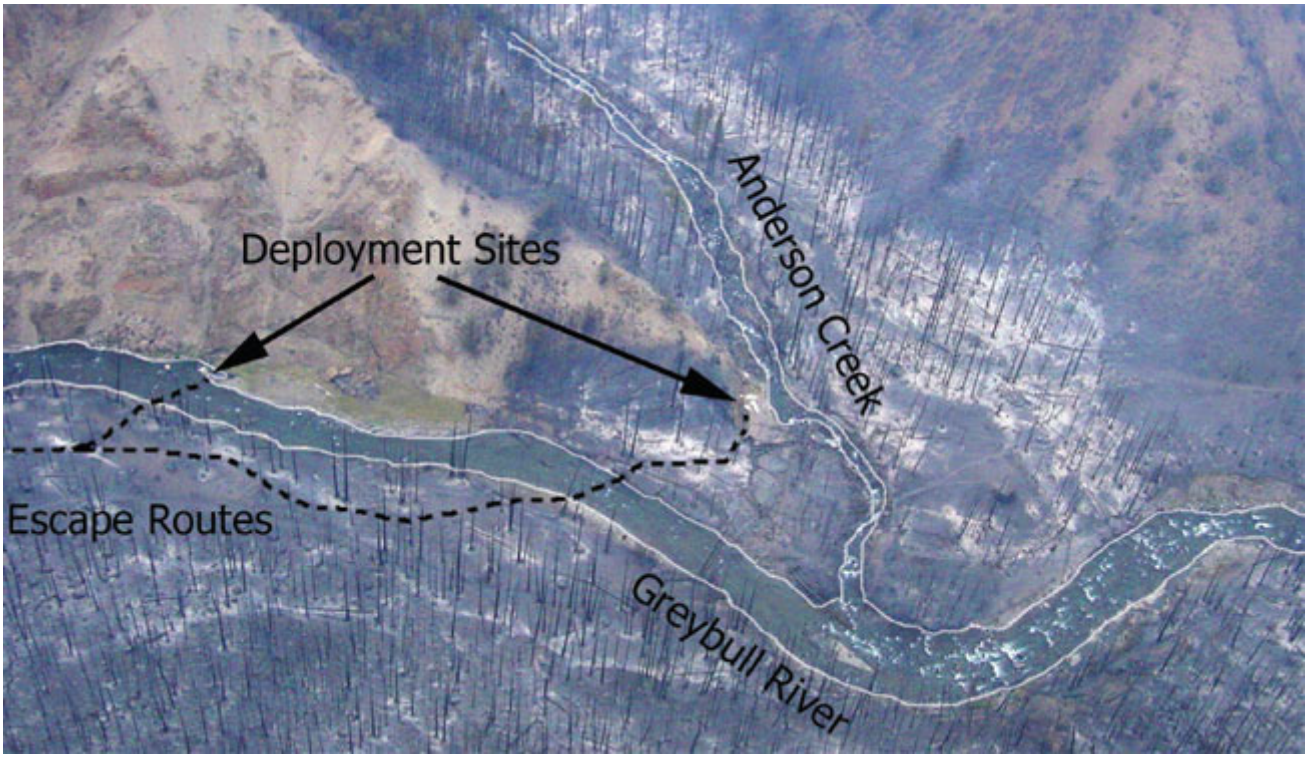

Figure 2—Ten firefighters on the 2005 Little Venus Fire escaped through the thigh-deep Greybull River and successfully deployed their fire shelters at two sites. One firefighter deployed on the rocks at the edge of the river while nine firefighters deployed fire shelters
on a gravel bar at the edge of Anderson Creek.

Figure 3—Firefighters watched the flames but did not see steam or boiling water at the edge of Anderson Creek during the fire shelter deployment at the 2005 Little Venus Fire.

Protecting the airway from extremely hot air is always a firefighter's primary concern. Firefighters must evaluate water bodies in the same way as any other potential deployment sites to make sure they're far enough from the flames. The cooling effect of a water body may allow firefighters to deploy closer to the flame front than would be indicated otherwise. But firefighters who are closer to the flame front will have a higher risk of breathing extremely hot, humid air that might damage their airways.

It is beyond the scope of this paper to offer specific criteria for evaluating possible water deployment sites.

Water Temperature

Your body loses heat more quickly in the water than in the air. Typical summertime water temperatures in streams or lakes may be as low as 50 to 60 degrees Fahrenheit. A person immersed in such cold water could become exhausted or unconscious in 1 to 2 hours (U.S. Search and Rescue Task Force, http://www.ussartf.org/cold_water_survival.htm). Entrapments may range from a few minutes to an hour or more. Long entrapments could lead to hypothermia (internal body temperature below 95 degrees Fahrenheit). In the Seven Oak deployment, firefighters recalled shivering after a 30-minute exposure in a stream-fed pond.

Force of Water

Moving water exerts a tremendous force that increases exponentially as the water's speed increases. As a current doubles its speed, it applies four times as much force on a submerged object (table 1).

Table 1—The force water applies to legs, body, or a swamped boat when the current is from 3 to 12 miles per hour (adapted from the Swiftwater Rescue Technician I Course, Rescue 3 International, Inc. at http://www.rescue3international.com/© 2009).

Current velocity (miles/hour)	**Average force of the water (pounds)**		
	Legs	**Body**	**Swamped boat**
3	17	34	168
6	68	134	672
9	151	302	1,511
12	269	537	2,687

Maintaining control of an opened shelter even in water moving slower than 3 miles per hour might be difficult because water could apply nearly as much force on the opened shelter as it would on a swamped boat.

Currents along the banks may push floating objects toward the center of the flow, where the current is fastest. Faster flows increase the danger that a firefighter could become entangled in the shelter and drown.

During a fire, streams also may carry fallen trees or other debris that could damage the fire shelter or injure its occupant.

Even when there is no current, a New Generation Fire Shelter may be extremely difficult to lift after it has been deployed in water. Once the head or foot of the fire shelter fills with water, the shelter could weigh up to 75 pounds (regular-size shelter) or 100 pounds (large-size shelter).

Other Hazards

Fallen power lines represent an electrocution hazard for firefighters deploying in water. Any deployment site could have other unexpected hazards. Scattered around the pond at the Seven Oak deployment site were three structures, gasoline containers, propane cylinders, large drums with unknown contents, and vehicles. The fire burned over all of these materials, presenting additional safety hazards to the firefighters.

Questions To Answer When Deploying a Fire Shelter in Water

Should you open the shelter before or after entering the water?

At the Seven Oak deployment, both methods were used. Opening the shelter in the water was much slower and more difficult. If firefighters drop an unopened shelter in deep water, it is more likely to be lost.

Should you hold the shelter in front of you as a shield or should you get into the shelter?

Both methods were successfully used at the Seven Oak deployment. Whenever the shelter is held in front of you as a shield, you have more risk of damaging your airways by breathing superheated air.

What body position works best under the shelter?

In the Seven Oak deployment, firefighters were sitting or kneeling in 2 to 3 feet of water underneath their opened shelters. Two firefighters shared a large-size New Generation Fire Shelter. They sat side by side underneath the shelter and were able to maintain an adequate airspace between their bodies and the hot shelter material.

What is the best way to maintain a breathable airspace while under the shelter?

Firefighters at the Seven Oak deployment rested the fire shelter on top of their heads while holding the shelter's sides down underneath the water. This approach sealed the shelter to the water. Some firefighters felt they needed to break the seal so they could breathe more easily, which worked in their situation.

What is the best way to maintain a protective airspace between your body and the fire shelter material?

At the Seven Oak deployment, firefighters pushed the shelter material away from their bodies. Firefighters must be careful not to become entangled in the shelter, especially in deep or moving water.

Problems of Deploying a Fire Shelter in Water

The problems of deploying a fire shelter in water include:

- Opening a shelter is difficult when you are wearing wet, slippery gloves and you are surrounded by water.
- Wet clothing will cling to the skin, eliminating the insulating airspace between clothing and the skin. Wet clothing may conduct heat to the skin more quickly than dry clothing, increasing the likelihood of burns.
- Safety goggles can fill with water or fog up, impairing vision.
- Manipulating a hardhat in the water can be difficult. A firefighter's hardhat may come off if the chin strap is not snug.
- Wet face and neck shrouds will droop, exposing a firefighter's face to heat.
- Breathing through a wet shroud or bandana exposes the airways to hot, moist air, which can be more harmful than hot, dry air. Avoid breathing through wet cloth.
- Waterlogged clothing and boots will become very heavy.

Conclusions

While bodies of water are not considered true safety zones, they may provide a survivable deployment site. Firefighters must evaluate all available options before deploying a fire shelter. If a water feature is chosen as the best alternative, firefighters should be prepared for the challenges of deploying in water.

About the Authors

John Smith joined MTDC in 2005 as an equipment specialist. He graduated from the University of Montana with a bachelor's degree in education and taught elementary school in Ovando, MT. He began his Forest Service career in 1974 as a wildland firefighter working for the Superior District of the Lolo National Forest. A Missoula smokejumper for more than two decades, Smith's experience as assistant loadmaster foreman, master parachute rigger, and safety program manager is applied to fire equipment development. Smith served as a fire shelter technical specialist during the Seven Oak Fire deployment interviews.

Tom Foley is the deputy chief at the Southern Operations Center of the California Department of Forestry and Fire Protection (CAL FIRE). He graduated from Central Michigan University with a bachelor's degree in education and from California State University, San Bernardino, with a master's degree in administration. Foley started his fire service career in 1987 as a volunteer firefighter and became a professional firefighter in 1992, working in both in the municipal and wildland fire environments. In 2006, as a member of the New Generation Fire Shelter Evaluation and Training Committee, he received the Governor's Employee Safety Award for extensive research and significant recommendations to improve the New Generation Fire Shelter. Foley represents CAL FIRE on the National Fire Protection Association 1977 Standard on Protective Clothing and Equipment for Wildland Firefighters Technical Committee, the National Wildfire Coordinating Group (NWCG) Equipment Technology Committee, and the NWCG Fire Shelter Task Group. He chairs CAL FIRE's Personal Protective Equipment Working Group.

Tony Petrilli is an equipment specialist for the fire and aviation and safety and health programs at MTDC. He has a bachelor's degree in education from Western Montana College. Petrilli began working for the Forest Service in 1982 and joined MTDC full time in 2000. He has worked as a firefighter for the Lewis and Clark and Beaverhead National Forests and as a smokejumper for the Northern Region. He is a division/group supervisor, type III incident commander, and has served on more than 20 fire entrapment review or investigation teams.

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