



# Prescribed Burning: Spotfires and Escapes

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Fire is an important ecological process that maintains prairies, shrublands and forests. Prescribed fire provides and helps maintain quality habitat for native wildlife, improves grazing for livestock, suppresses invasive woody plant growth and reduces wildfire risk on the land. Every year, millions of acres are intentionally and safely burned across the nation<sup>1</sup>. However, there is always the possibility of a spotfire and escaped fire occurring. In some cases, the perceived risk and liability of an escape is enough to prevent prescribed fire use altogether. The best way to prevent a spotfire from becoming an escaped fire is to be prepared and plan ahead.

## What are Spotfires and Escaped Fires

There are two types of ignitions that can occur outside of a designated burn area when conducting prescribed fires. Spotfires are defined as ignitions that occur outside the burn area, but extinguished by personnel and equipment on site<sup>2</sup>. Spotfires are typically caused by windborne embers (also known as firebrands) from a variety of sources such as

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crowning trees, snags, heavy fuels along the fireline, volatile fuels, brush piles and windblown grass or leaf litter. Fire and smoke whirls, falling trees and flames reaching or creeping across the fireline can also ignite spotfires. The second type of off-site ignition is an escaped fire, which begins as a spotfire, but becomes too large or difficult for on-site equipment and personnel to extinguish and outside resources (e.g., local fire department) are necessary to help suppress the fire<sup>2</sup>.

## Spotfire Development

Spotfires typically ignite in fuels downwind or adjacent to the burn area, with size being dependent upon several factors. In light winds or early stages of formation, most spotfires burn to form a circle with growth being slow or rapid depending upon weather and fuel conditions. Typically, a spotfire will remain in a circular pattern growing from the point of origin until it is large enough to be carried by the wind. Wind speed is one of the largest contributing factors affecting rate of spread followed by topography, fuel loading, fuel continuity and moisture<sup>3</sup>. If winds are light, the spotfire will almost be as wide as it is long. If winds are strong the fire will be long and narrow. Topographical features such as slope and aspect can also affect spotfire development. Fires typically burn faster uphill due to fuel pre-heating. North and south aspects, for example, may have different fuel types and conditions depending on the time of year impacting spotfire growth and development.

## Spotfire Probability

As reported on the prescribed burn entry form for 2015–2016 on the Oklahoma Prescribed Burn Association website ([www.ok-pba.org](http://www.ok-pba.org)), out of 661 reported prescribed fires covering 293,739 acres, there were 107 spotfires and 24 escaped fires. This equated to a 16.2 percent probability of a spotfire and 3.6 percent probability of an escaped fire occurring. Further, 81 percent of all spotfires reported burned less than 1 acre, with only one greater than 100 acres. There were no reported insurance claims or lawsuits resulting from any of these outside ignitions. Likewise, a survey of landowners burning with Prescribed Burn Associations in the southern Great Plains found that from 1995–2012, on 1,094 prescribed burns collectively covering nearly 500,000 acres there were 224 spotfires (20 percent) and 16 escapes (1.5 percent), ranging from less than 0.1 to 2,000 acres in size<sup>2</sup>. Again, no



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insurance claims or lawsuits were filed in response to any of these outside ignitions. Another study reported 21 spotfires on 99 burns<sup>4</sup>, again showing that spotfires typically occur on one out of five burns. While this information indicates spotfires and escape fires are not common, they do still occur and the best way to reduce the likelihood of a fire escaping is to be prepared for a spotfire.



Spotfires are defined as ignitions that occur outside the burn unit, but extinguished by personnel and equipment on site<sup>2</sup>. The second type of off-site ignition is an escaped fire which begins as a spotfire but becomes too large or difficult for on-site equipment and personnel to extinguish and outside resources (e.g., local fire department) are necessary to help suppress the fire<sup>2</sup>. (Photos top J. Weir, bottom P. Bauman)

### What if it Spots or Escapes?

Being prepared for spotfires and escaped fires should be addressed in the burn plan and while briefing the fire crew before the burn. Preparing personnel on what to expect, how to react and what to do in the event of a spotfire will reduce confusion, risk of injury and the size of the spotfire. Moreover, it is strongly recommended that fire crews complete some type of spotfire training before participating in prescribed fires. Trying to contain spotfires with novice crews can be challenging and increase the likelihood of an escaped fire and injury.

Everyone on the fire crew should know and understand that the fireboss or person they designate is the only person that will call for assistance if needed. If the fire does spot,

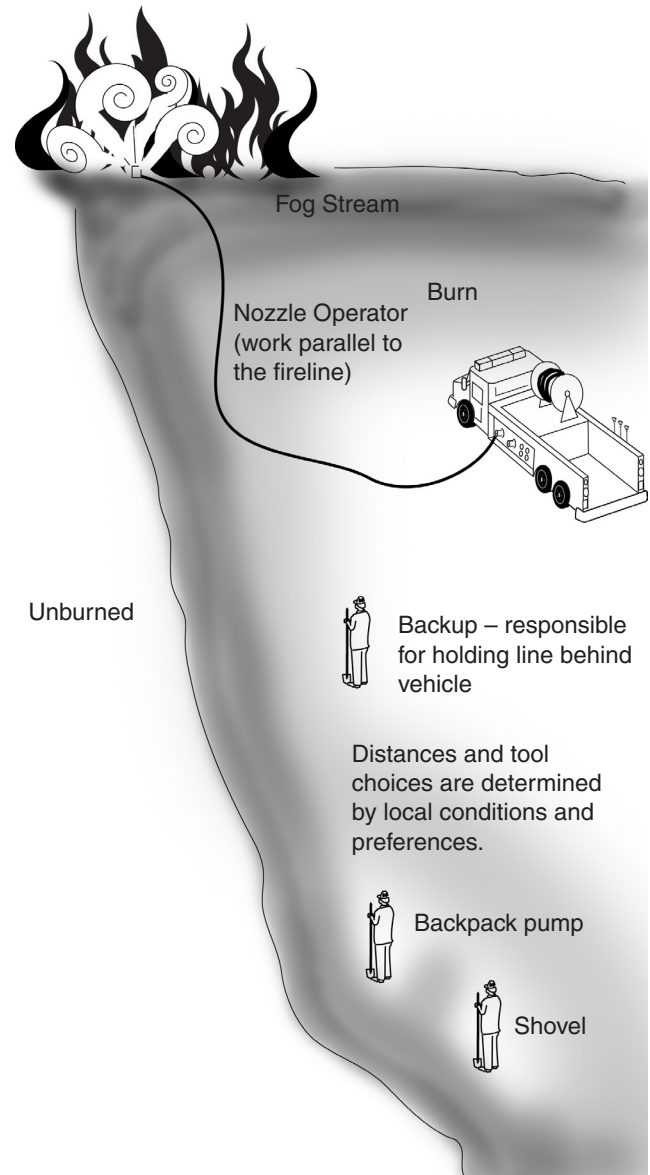


In light winds or early stages of formation, most spotfires burn to form a circle with growth being slow or rapid depending upon weather and fuel conditions (top photo). Typically, a spotfire will remain in a circular pattern growing from the point of origin until it is large enough to be carried by the wind. Wind speed is one of the largest contributing factors affecting rate of spread followed by topography, fuel loading, fuel continuity, and moisture<sup>5</sup>. (Photos J. Weir)



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then all ignitions should immediately cease. Next, personnel and equipment should begin to go to the area where the spotfire started. Remember, not everyone should go assist with suppression. Some personnel need to stay and monitor the prescribed fire that is still actively burning within the area. Remind personnel that when traveling to the spotfire and escaped fires in vehicles, to drive safely and watch for personnel on foot along the way. It is important for suppression vehicles to arrive quickly, but more important for them to arrive safely.

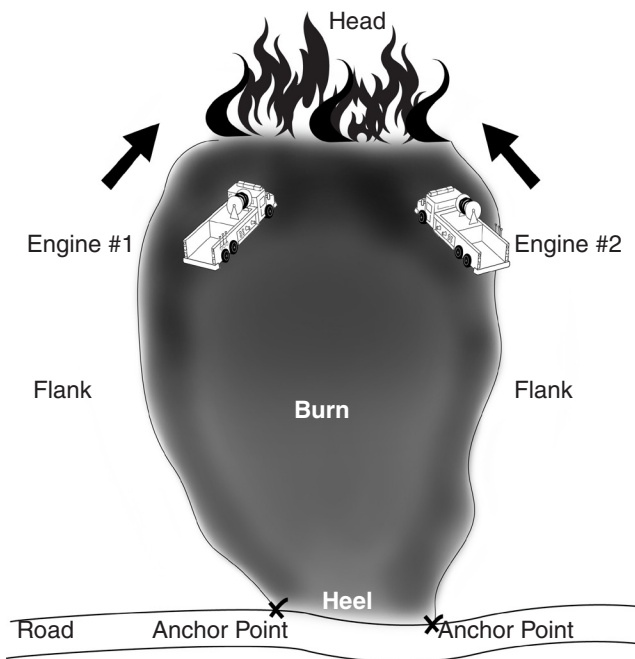


Always anchor the suppression effort to keep fire from coming around and trapping personnel and equipment. Have the most effective sources of water, such as slip-on pump units or ATV sprayers lead the way. This equipment has the ability to knock back intense flames and heat. Personnel with backpack pumps, leaf blowers and hand tools should follow them up to suppress hot spots and flare-ups. (Illustration from USDI-BLM, NFES 1384)

## Suppressing a Spotfire and Escaped Fire

When suppressing spotfires that have just formed, direct attack by one or two personnel with hand tools, backpack pump, ATV sprayer or pumper unit are good methods. These tools should quickly and effectively suppress most small spotfires. However, as the spotfire gets larger, more coordination and cooperation are necessary to effectively and safely suppress it. When attacking a growing spotfire, never get in front of the headfire to suppress it. Instead, use the blackened area that has already burned to your advantage by placing people and equipment “in the black.” Working in the black allows for easier and safer fire suppression.

When suppressing a growing spotfire with more equipment and personnel, make sure to place them where they are most effective. This effort should be directed by the burn boss. First, begin suppressing the spotfire at an anchor point on the upwind side. Always anchor the suppression effort to keep fire from coming around and trapping personnel and equipment. Have the most effective sources of water, such as slip-on pump units or ATV sprayers lead the way. This equipment has the ability to knock back intense flames and heat. Personnel with backpack pumps, leaf blowers and hand tools should follow them up to suppress hot spots and flare-ups. As the crew progresses along the fireline toward the headfire, they should always check the area toward the anchor point to make sure it has not reignited. Reignition can build into a subsequent headfire, leading to entrapment and injury of personnel along the fireline.



**If enough personnel and equipment are available, two crews can be used – one crew will work up the short flank while the other crew will work up the long flank eventually meeting at the headfire. This suppression technique is referred to as a pincer or double envelopment method. (Illustration from USDI-BLM, NFES 1384)**



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**If direct attack is not working or cannot be accomplished due to terrain or vegetation restrictions on personnel and equipment, it may be necessary to use indirect suppression methods. An example of indirect suppression is pulling back to an existing firebreak, such as road, creek or cultivated field and igniting a backfire to suppress the oncoming fire. Again, this type of action (i.e., contingency plan) should be outlined in the burn plan and communicated among the crew prior to conducting the burn. (Photo T. Johnson).**

If enough personnel and equipment are available, two crews can be used – one crew will work up the short flank, while the other crew will work up the long flank, eventually meeting at the headfire. This suppression technique is referred to as a pincer or double envelopment method. If only one pumper truck or larger source of water is available with this method, send it up the short flank as the primary suppression tool, followed by backpack pumps and hand tools. Backpack pumps and hand tools should have the ability to suppress the long flank because it is typically less intense.

When working with multiple personnel, remember that rapid movement down the fireline is the most efficient suppression method. It is not necessary for the lead individual (or even second or third person) to suppress every flame and hot spot while working toward the headfire. Instead, lead personnel can rely on the individuals behind them to completely suppress the fire. However, as noted above, all crew members need to continuously look behind them to ensure flare-ups do not occur. After the spotfire has been suppressed, leave a few crew members behind to monitor and mop up the edges. The remaining crew can now return to complete the prescribed burn.

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prior to conducting the burn. Several questions should also be considered before setting a backfire. First, can the new backfire be safely contained with the personnel and equipment available? Will additional fire help the situation? Is it safe for personnel and people in the area? Is there enough time for the backfire to do its job before the arrival of the headfire? Remember, the backfiring process can be relatively slow.

## Reducing Spotfire Risk

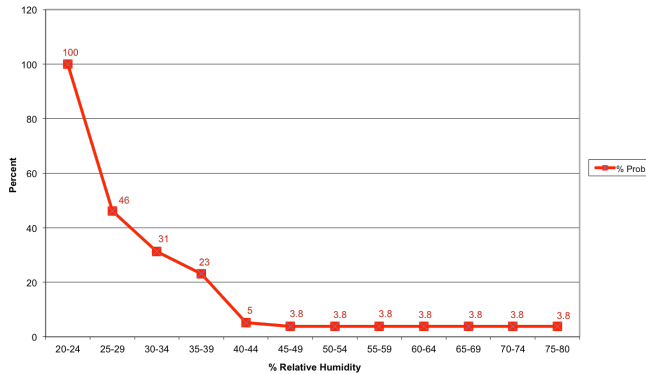
There are several actions that can be done to reduce the risk of spotfires. First, burn when weather conditions are safest and well within prescription. This can be accomplished by burning using the 60/40 rule, which recommends burning when the temperature is below 60 F, and relative humidity is above 40 percent. It has been shown that burning with the temperature below 60 F reduces the distance firebrands travel downwind<sup>6</sup>. At the same time, burning when relative humidity is above 40 percent slows the fire rate of spread and reduces danger from firebrands<sup>7,8</sup>.

Relative humidity has been found to be a good indicator of spotfire occurrence<sup>4</sup>. The probability of a spotfire occurring on a prescribed burn with the relative humidity between 20 and 80 percent was determined to be 21.2 percent or approximately one out of five burns<sup>4</sup>. There appears to be two critical humidity thresholds in relation to spotfire probability, at 40 percent and 25 percent relative humidity. Below 40 percent relative humidity there is a 41.3 percent probability for a spotfire occurring and 3.8 percent chance above 40 percent humidity. At less than 25 percent relative humidity, there is a 100 percent probability of a spotfire occurring.

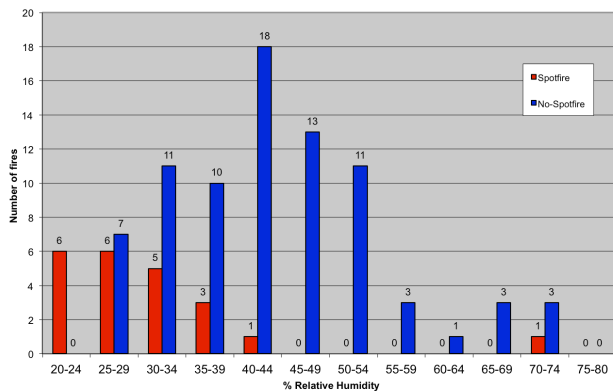
## Fuel Reduction Close to the Firebreak

Another way to reduce spotfire risks is to reduce the amount or type of fuel close to the firebreak, especially on the downwind or backfire side. In burn units with heavy fine fuel loads or tallgrass fuels along the firebreak, mowing can help reduce spotfire risks. Where possible, mow inside the firebreak 10 to 50 feet to reduce fire intensity, flame length

Percent Probability of Spotfire Occurrence  
n=99



Spotfire Occurrence  
n=99



There appears to be two critical humidity thresholds in relation to spotfire probability, at 40 percent and 25 percent relative humidity. There is a probability of 41.3 percent for a spotfire occurring below 40 percent and 3.8 percent above 40 percent. At less than 25 percent relative humidity, there is a 100 percent probability of a spotfire occurring<sup>4</sup>.



In burn units with heavy fine fuel loads or tallgrass fuels along the firebreak, mowing can help reduce spotfire risks. Where possible, mow from the firebreak 10 to 50 feet to reduce fire intensity, flame length and the probability of leaves from grass fuels blowing across the firebreak. (Photo B. Reavis)



**In areas where spotfires are likely to occur, have personnel act as lookouts and position equipment so they can react quickly before the spot grows very large. (Photo C. Stanley)**

and the probability of leaves from grass fuels blowing across the firebreak. In areas with volatile fuels, such as cedar or juniper growing next to the firebreak, cut them down and remove them or push them into the burn unit at least 300 to 500 feet. This helps to reduce embers from carrying past the firebreak causing a spotfire.

## Lookouts

In areas where spotfires are likely to occur, have personnel act as lookouts and position equipment so they can react quickly before the spot grows very large. When burning units along fencelines, place personnel and equipment on the opposite side of the fence, so they are able to respond quickly to any spotfires without having to drive to find a gate, cross or cut the fence. When using mowed lines/wet lines, mop-up should begin as soon as possible to prevent fire from creeping across the line. Make sure that lookout personnel are monitoring outside of the burn area. People often want to watch the fire and forget that they should be watching downwind outside of the burn unit.

## Monitor the Weather

Often, a lot of time is spent monitoring weather conditions for the day of the burn, but attention is just as important for weather conditions one to three days post-burn. Numerous spotfires occur a day or two after the initial burn due to smoldering fuels flaring up caused by high winds or changes in wind direction, as well as lower relative humidity. Be sure to check the forecast, not only for the day of the burn, but the next several days, especially if there is going to be residual fuels

burning or smoldering. Be prepared to mop-up and monitor the unit for several days until it is 100 percent extinguished if post-fire weather is a concern (e.g., high winds, high temperatures, low humidity).

## Summary

Prescribed fire is important and useful for the management of our lands, but it does come with some inherent risk. Spotfires are going to occur when conducting prescribed burns; data indicates one out of five burns will experience a spotfire. However, with the appropriate knowledge and action as described above, the likelihood of a subsequent escaped fire is reduced. A comprehensive burn plan outlining contingency plans for spotfires and escaped fires is essential. Secondly, a crew trained in spotfire suppression is recommended. To reduce spotfire occurrence, do not burn with low humidity conditions, reduce fuels along the fireline, post lookouts and select burn days with proper weather conditions for the burn unit.

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