



Conducting a Prescribed Burn and Prescribed Burning Checklist

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This publication is a guide to prescribed burning of grassland (low-volatile) fuels. However, it cannot replace actual burning experience.

The interacting forces of climate, fire and grazing formed and maintained the grasslands of the Great Plains of North America. Native Americans were the first to use fire to manipulate plant communities primarily to attract bison to lush regrowth. With the arrival of Europeans, the deliberate setting of fire was greatly curtailed because of the loss of property and potential loss of life associated with wildfires. Today, land managers realize that fire or prescribed burning is an effective tool to manage grasslands.

Prescribed burning is dangerous when handled by the inexperienced person who may become over-confident and inadvertently let a fire escape. A beginner should participate in a number of prescribed burns under the supervision of an experienced person. These burns should be conducted over a wide variety of weather, fuel and topographic conditions. It is imperative to learn how weather, fuel and topography interact to influence fire behavior before accepting the responsibility of conducting a prescribed burn.

A prescribed burn is a fire applied in a skillful manner to grassland fuels, in a definite place, for a specific purpose, under proper weather conditions, to achieve specific management objectives. Safety is of utmost concern and can be

assured with proper planning and coordination. Prescribed burning can be used to reduce undesirable plants and encourage desirable species; increase herbage production, nutritive quality, and palatability; enrich wildlife habitat; and remove herbaceous plant debris. It is essential to consider the following items when preparing for and conducting a prescribed burn.

1. Legal Obligations
2. Equipment
3. Personnel Requirements
4. Burning Prescription
5. Notification of Neighbors
6. Fireguard Construction
7. Ignition Techniques
8. Smoke Management

Legal Obligations

In Nebraska, a burning permit from the fire chief with jurisdiction over the area to be burned is required. The fire chief will need to know the location and the proposed burn date. After receiving the burning permit, any changes in the burn date must be approved by the fire chief. Check with the local fire chief to see if additional permits are required. The permit states that the applicant is liable for damages that may result from the fire (*Figure 1*).

Open Burning Permit

Date Issued _____

This permit issued to:

Owner's Name: _____ Phone # _____

Burn location: _____

Person supervising burning: _____ Phone # _____

DATE and time of burn: _____ DATE _____ from _____ TIME _____ to _____ TIME _____

DESCRIPTION OF MATERIAL TO BE BURNED: _____

Signature of person(s) assuming responsibility in event fire becomes out of control: _____

Signed: _____ Dispatcher Phone # _____

This permit is being issued in accordance with Nebraska Statute 81-520.01. (See Back) Air quality regulations may necessitate an additional permit from the Department of Environmental Control. Phone (402) 471-2186.

Figure 1. Example of a burning permit that must be obtained from the local fire chief before conducting a prescribed burn.

LEGISLATIVE BILL 408

81-520.01. (1) There shall be a statewide open burning ban on all bonfires, outdoor rubbish fires, and fires for the purpose of clearing land.

(2) The fire chief of a local fire department or his or her designee may waive an open burning ban under subsection (1) of this section for an area under his or her jurisdiction by issuing an open burning permit to a person requesting permission to conduct open burning. The permit issued by the fire chief or his or her designee to a person desiring to conduct open burning shall be in writing, signed by the fire chief or his or her designee, and on a form prescribed by the State Fire Marshal. The State Fire Marshal shall provide local fire departments with such forms.

(3) The fire chief of a local fire department or his or her designee may waive the open burning ban in his or her district jurisdiction when conditions are acceptable to the chief or his or her designee. Anyone burning in such district jurisdiction when the open burning ban has been waived ~~must~~ shall notify the fire department of his or her intention to burn.

(4) The fire chief of a local fire department may adopt and promulgate rules and regulations listing the conditions acceptable for issuing a permit to conduct open burning under subsection (2) of this section.

(5) The local fire department may charge a fee, not to exceed ten dollars, for each such permit issued. This fee shall be remitted to the governing body for inclusion in the general funds allocated to the fire department. Such funds shall not reduce the tax requirements for the fire department. No such fee shall be collected from any state or political subdivision to which such a permit is issued to conduct open burning under subsection (2) of this section in the course of such state's or political subdivision's official duties.

Sec. 2. That section 81-520.02, Revised Statutes Supplement, 1992, be amended to read as follows:
81-520.02. Any person violating the statewide open burning ban established by section 81-520.01 or violating sections 3 to 5 of this act shall be guilty of a Class V-IV misdemeanor.

Sec. 3. For purposes of sections 4 and 5 of this act, range-management burning shall mean the controlled application of fire to existing vegetative matter on land utilized for grazing.

Sec. 4. The fire chief of a local fire department or his or her designee may waive an open burning ban under subsection (1) of section 81-520.01 by issuing a permit for range-management burning only if the range-management burning is to be conducted in accordance with section 5 of this act.

Sec. 5. (1) A landowner, tenant, or other landowner's agent of the land where range-management burning is proposed shall file an application for a permit and a plan for conducting such burning. The plan shall include:

(a) The name of the landowner of the land on which range-management burning is to occur;
(b) The name of the person who will supervise the range-management burning if such person is different than the landowner;

(c) The land-management objective to be accomplished;

(d) A map showing the areas to be burned, including natural and manmade firebreaks;

(e) Procedures to be used to confine the fire in boundary areas without preexisting firebreaks;

(f) A list of equipment that will be on hand;

(g) The types of conditions of the vegetative matter to be burned on the land and in adjacent areas;

(h) Identification of roads and habitations that may be affected by smoke;

(i) A description of weather conditions believed to be required to safely and successfully conduct the range-management burning, including wind speed and direction, temperature, and relative humidity; and

(j) Such other information as may be prescribed by the fire chief of a local fire department.

(2) The fire chief of a local fire department or his or her designee shall evaluate each plan to determine its compliance with subsection (1) of this section. If a plan fails to comply with all provisions of such subsection, a permit for range-management burning shall not be issued.

(3) The fire chief of a local fire department or his or her designee shall issue a permit for range-management burning if (a) the plan complies with subsection (1) of this section and (b) the fire chief or his or her designee determines that range-management burning conducted in accordance with the plan would be conducted with due regard for the safety of people and property outside the burning areas. No permit shall be valid for more than thirty days.

Sec. 6. That original section 81-520.01, Reissued Revised Statutes of Nebraska, 1943, and section 81-520.02, Revised Statutes Supplement, 1992, are repealed.

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Figure 2. LB408, which cites the legal requirements the prescribed burn initiator and fire chief must follow.

Equipment

A safe and effective prescribed burn requires the following equipment:

1. Water pumper
2. Weather kit
3. Ignition devices
4. Fire suppression tools
5. Two-way radios (on large areas)
6. Protective clothing

Have ample water and a dependable delivery system at the site during a prescribed burn. A slip-on water pumper designed for fire suppression and which fits in a truck bed is preferred. A tractor-mounted sprayer with a hand nozzle also can be used. Water pumpers should have at least 100 gal (388 l) capacity, 50 ft (15 m) of hose, and a nozzle with adjustable spray settings.

Fire behavior is strongly influenced by weather. A weather kit contains instruments to quickly measure the weather conditions at the burn site. A fire weather kit contains: 1) a sling psychrometer to measure relative humidity and air temperature, 2) an anemometer to determine wind speed, and 3) a compass to determine direction. Relative humidity, air temperature, and wind speed and direction should be recorded often to monitor weather changes that could influence fire behavior.

Drip torches are most commonly used for ignition. They have a 5-quart (4.5 liter) fuel capacity and safety features that reduce the possibility of flashback and fuel leakage. The recommended fuel mixture for a drip torch is 50 percent diesel and 50 percent gasoline. The amount of gasoline can be reduced to as little as 30 percent if increased air temperature causes flashing or fuel surging at the drip torch nozzle.

Hand tools are important in fire suppression. Shovels, axes and rakes can be used to remove vegetation that crosses fireguards. Fire swatters and backpack sprayers can help extinguish low-intensity fires or slow fire spread until the water pumper can be brought into action. Fence cutters increase access to surrounding areas if the fire escapes.

Crew members need reliable communications during a prescribed burn. On larger areas, communication links are best maintained with two-way radios. Radios may not be necessary on small areas where crew members are always within sight of one another. Where service is available, cell phones may also serve as a communications link.

Proper clothing can protect an individual during a prescribed burn. Clothing made of either cotton or wool is recommended, since these fibers will not melt when brought close to a fire. Fire crew members should not wear clothing with man-made fibers such as polyester for the same reason. Clothing treated with fire-retardant

chemicals provides good protection, and should be layered over cotton clothing. Leather gloves with large cuffs are recommended. Boots should have leather uppers for ankle support and hard rubber lug soles for traction. Slip-on boots with soft rubber soles are not recommended as they soften and melt when exposed to higher temperatures. A hard hat provides protection from falling debris when burning near or in a stand of trees. Goggles protect eyes from smoke and particulate matter.

Burning Prescriptions

A fire prescription is a guideline for conducting a prescribed burn. A proper prescription enables the land manager to safely burn an area and achieve desired objectives. Specific fire prescriptions depend on the factors that influence fire behavior: weather conditions, fuel characteristics and topography.

The more important weather variables are relative humidity, air temperature and wind speed. Relative humidity describes the ratio of the actual to the potential amount of water vapor that could be held in a given volume of air at a given temperature. In grasslands, relative humidity strongly influences the moisture content of the fuel and the ease with which it ignites and burns. High air temperature favors a high fire temperature and reduces the time needed to preheat fuel to the point of combustion.

Fire behavior is more predictable with moderate wind from one direction. Wind improves burning conditions by providing the fire with oxygen and accelerating the preheating of fuel ahead of the fire front. A consistent wind from one direction increases the control of the fire front and reduces the risk of escape. Avoid burning on days with light and variable winds.

Fuel characteristics that affect fire behavior include the amount of fine (grasses and some forbs) and coarse (woody plants) fuel, and vegetation continuity and volatility. Generally, at least 750 lbs/acre (840 kg/ha) of uniformly distributed fine fuel is required to conduct a prescribed burn. However, to effectively manage eastern redcedar (*Juniperus virginiana* L.), 1500 lbs/acre (1680 kg/ha) of uniformly distributed fine fuel is required to maximize mortality.

As fine fuel increases, the flexibility of the prescription increases and the temperature generated by the fire front increases. Temperatures of more than 600°F (316°C) can occur at the soil surface within one minute when fine fuel loads greater than 7000 lbs/acre (7840 kg/ha) are ignited. However, because of its finely divided nature, the grass fuel is rapidly consumed by the fire and within four to five minutes after ignition the temperature will be below 200°F (93°C).

Knowing the volatility of the dominant vegetation on the area to be burned is important. High-volatile vegetation contains high amounts of volatile compounds, such as fats, waxes and oils. Firebrands (burning plant debris lofted into the air) are produced when high-volatile vegetation burns and can cause spot fires outside the burn area. Examples of high-volatile vegetation include eastern redcedar, ponderosa pine (*Pinus ponderosa* Laws.), and saltcedar (*Tamarix ramosissima* Ledeb.). Low-volatile vegetation — most grasses and hardwood trees — contain smaller amounts of volatile compounds and are less flammable as high-volatile vegetation.

Topographic features, aspect and slope, affect fire behavior by influencing weather and fuels. Aspect is the direction a slope faces. Because of more exposure to the sun's rays, south-facing slopes tend to be drier and warmer than slopes with a northern aspect. For this reason, fires on south-facing slopes can be more intense than those on north-facing slopes. Regardless of aspect, fire spreads more rapidly upslope than either downslope or over level ground. A fire moves upslope quickly because heat is transferred more rapidly to the unburned fuel ahead of the flaming front. This rapid heat transfer reduces the time needed for the unburned fuel to ignite.

General prescriptions have been developed for widening fireguards with fire and igniting headfires (*Table I*). These prescriptions should be refined as one gains experience using fire. In certain situations, it may be necessary to deviate from these guidelines. When there is excessive fine fuel it may be safer to burn when the relative humidity is above 40 percent, air temperature is between 40 and 50°F (5 and 10°C), and wind speed is between 6 to 8 mph (10 to 13 km/hr). Before deviating too far from the prescription, ignite a test fire on a small, downwind portion of the burn area. Use an area for a test fire where the fire can be extinguished quickly and easily. This test fire provides information on fire behavior that can be used to decide whether to continue burning or wait for more favorable conditions. There are weather conditions under which burning should not be done (*Table II*). Burning under these conditions is dangerous because fire behavior is very erratic.

Table I. Prescriptions for using fire to widen fireguards and to ignite headfires.

Weather Variable	Purpose of the Fire	
	Widening Fireguards	Igniting Headfires
Relative Humidity (%)	40 – 60	25 – 40
Air Temperature (°F)	40 – 60	50 – 70
Wind Speed (mph) ¹	3 – 8	8 – 12

¹Wind measurement taken 6 ft (1.8 m) above the soil surface.

Table II. Weather conditions under which burning should not occur.

Weather Variable	Do Not Burn
Relative Humidity (%)	less than 20
Air Temperature (°F)	greater than 80
Wind Speed (mph) ¹	greater than 20

¹Wind measurement taken 6 ft (1.8 m) above the soil surface.

Caution: Whirlwinds causing firewhirls may develop as a result of wind shear when a backfire and headfire meet or when burning across ridges. To reduce the possibility of creating firewhirls, do not run a headfire into a backfire, burn when weather conditions are appropriate, and burn with the ridges, not across them.

Fireguard Construction

A fireguard should be built around the entire perimeter of the burn area to prevent a fire escape. *Figures 3A* and *3B* illustrate construction options when burning low-volatile vegetation. Natural breaks in the vegetation, such as cattle trails, areas of sparse vegetation, roads, or waterways, can be used as fireguards. Where there are no natural breaks, use a combination of mowing and wetlining. Close to the anticipated burn date, mow a 15 to 20 ft (4.6 to 6.1 m) wide strip of vegetation to 2-4 in (5 to 10 cm) high around the perimeter of the area. Bale and move the mowed material well away from the burn area or scatter the material across the area to be burned. Do not leave the baled hay in the burn area. Hay bales are compact, will burn for a long time and can be a safety hazard. The day of the burn, wet a 3 ft (0.9 m) wide strip on the downwind side of the mowed swath and immediately ignite along the upwind side of the wetline. A chemical fire retardant can be mixed with the water to increase the effectiveness of the wetline. Weather conditions in the morning should favor a cool, slow-moving, and easily-controlled fire. Although the combination of mowing and wetlining is effective, it can be time-consuming and labor-intensive if weather conditions are not right, or if the amount of grass along the fireguard is excessive.

Plowing or discing a narrow strip, 4 to 8 ft (1.2 to 2.5 m) wide around the burn area creates a firebreak and reduces the time needed to widen fireguards the day of the burn. Plowed or disced firebreaks, especially on slopes, are subject to erosion and should be revegetated following the burn. When plowing, set the plow so soil and plant debris are turned to the outside of the burn area. When discing, there should be enough soil disturbance to eliminate any fine fuel that might carry a fire across the disced firebreak.

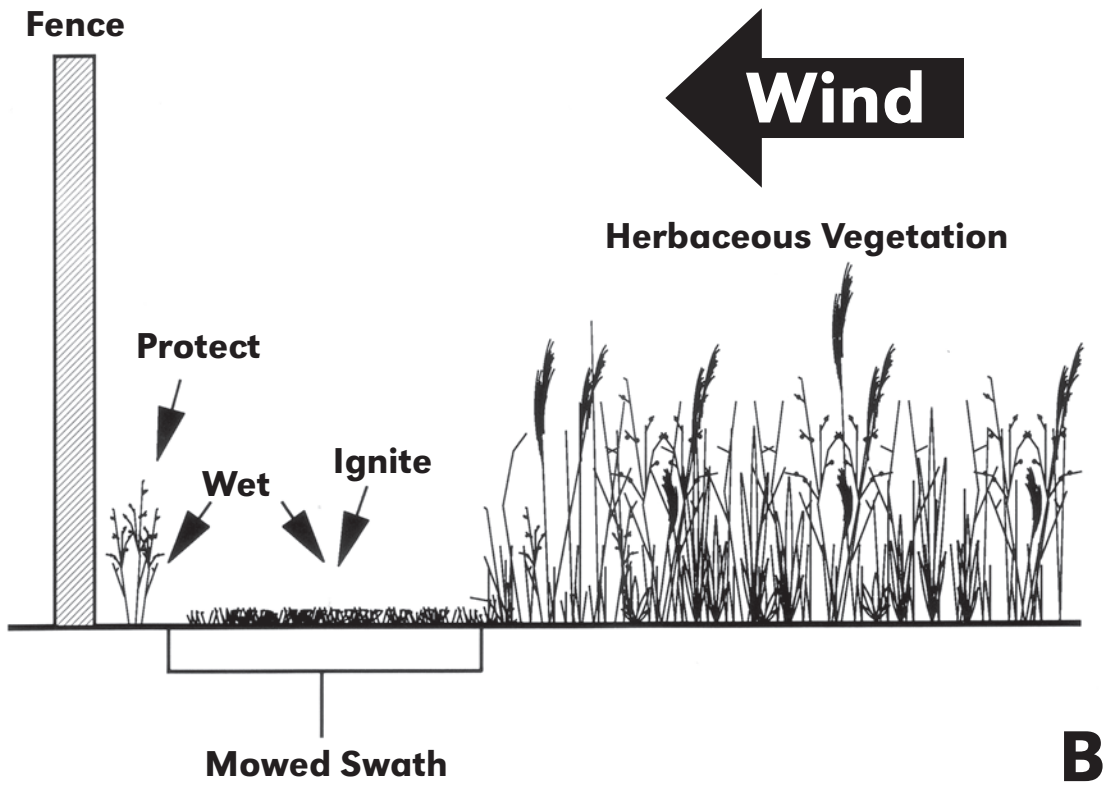
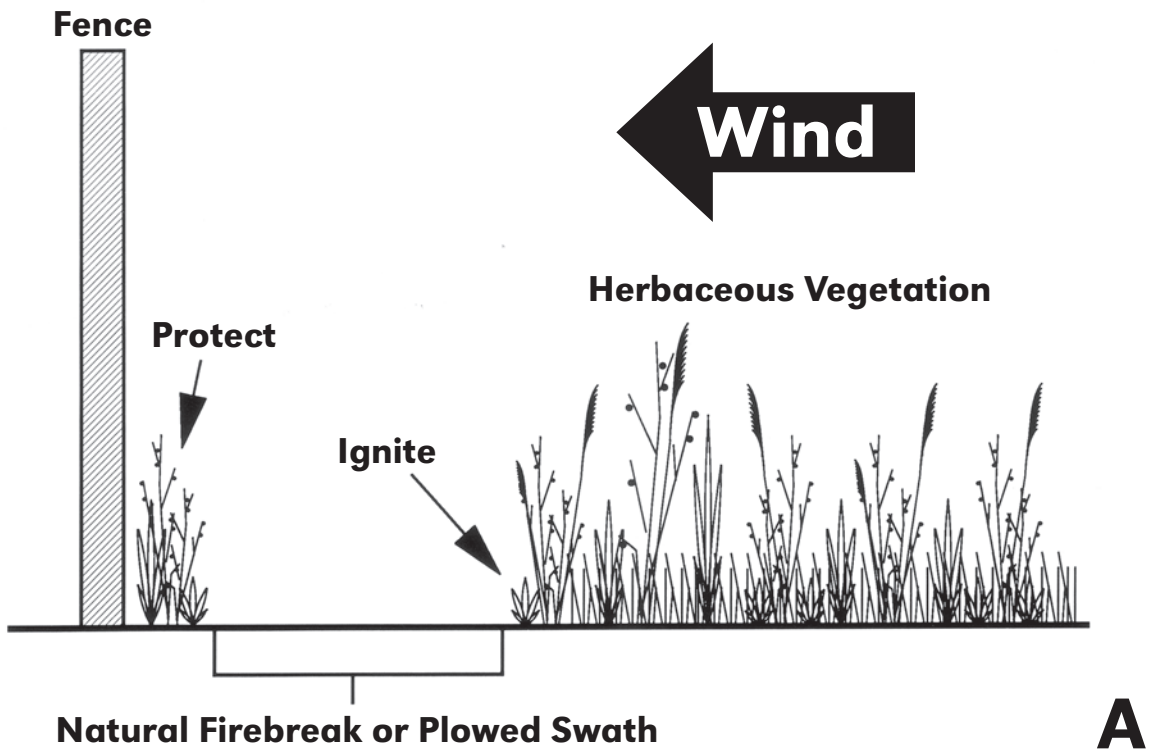


Figure 3A-B. Firebreaks and fireguard construction using a backfire. (A) uses a naturally occurring firebreak or plowed swath and (B) a combination of a wetline and mowed swath.

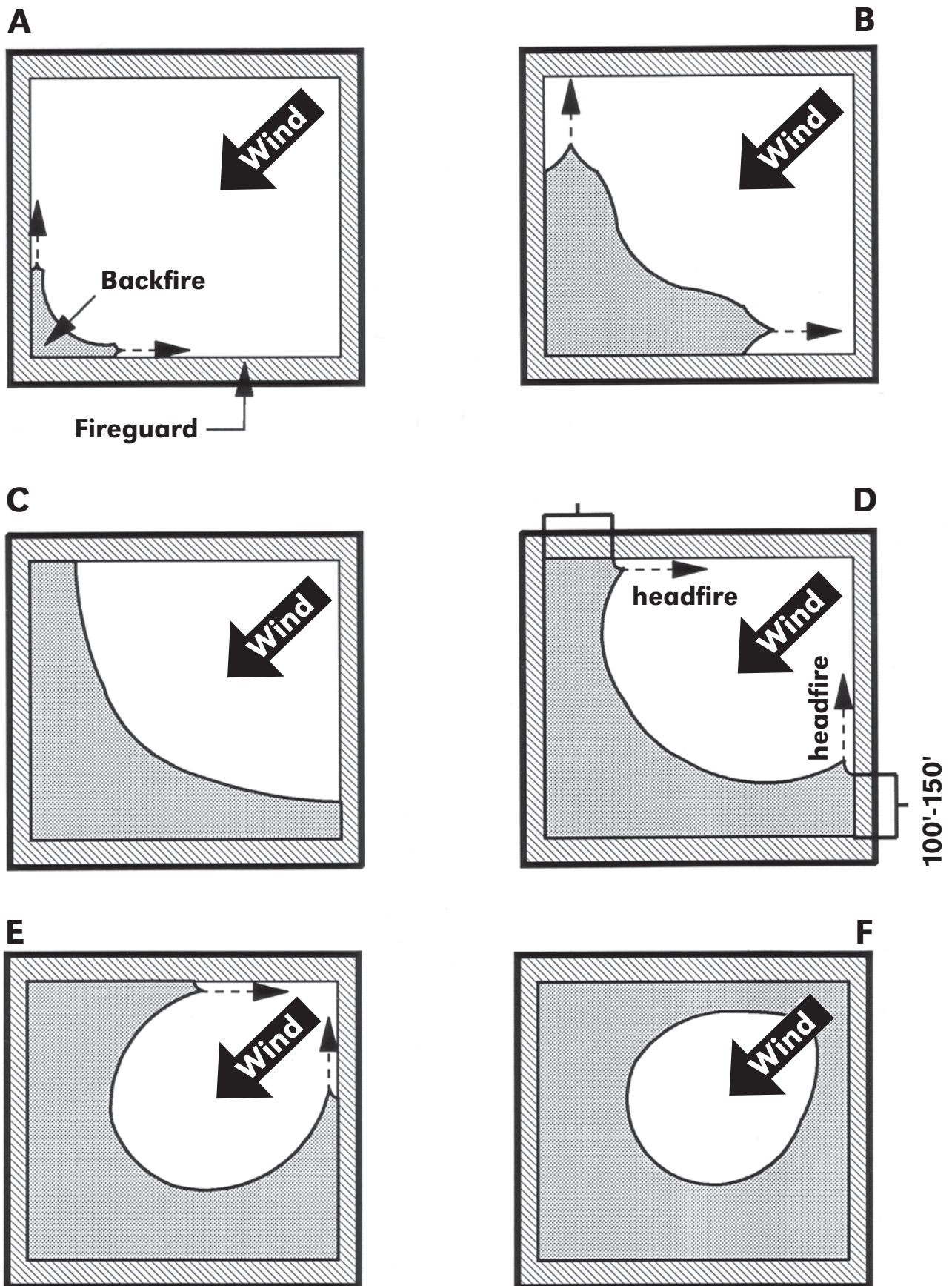
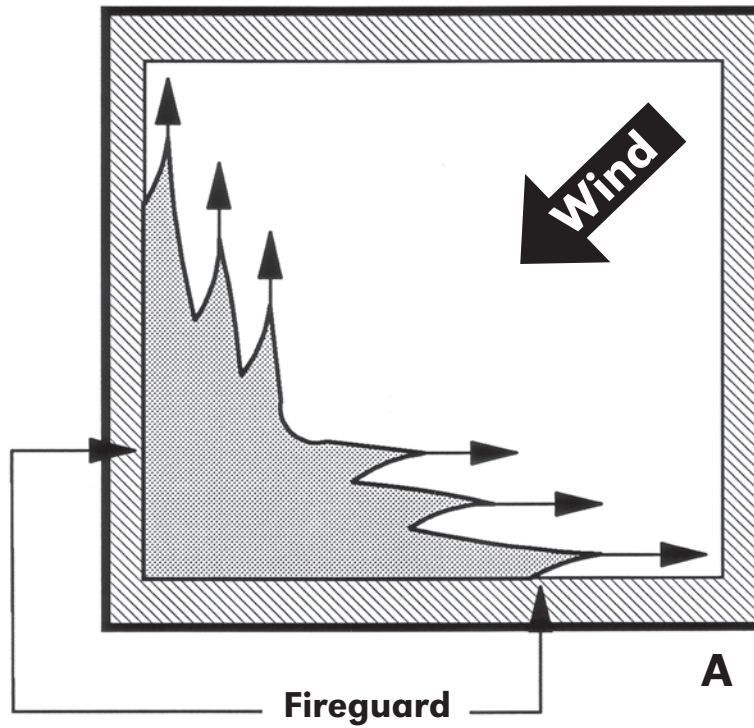


Figure 4A-F. Sequence of events when burning a pasture dominated by grass (low-volatile fuel). (A), (B), and (C) using a backfire to widen fireguards on the downwind side of the pasture; (D) fireguards widened to 100 to 150 ft (30 to 45 m); (E) initiate headfire ignition; and (F) completion of the headfire ignition. Direction of ignition is indicated by arrows.

Strip — Headfire



Flank Fire

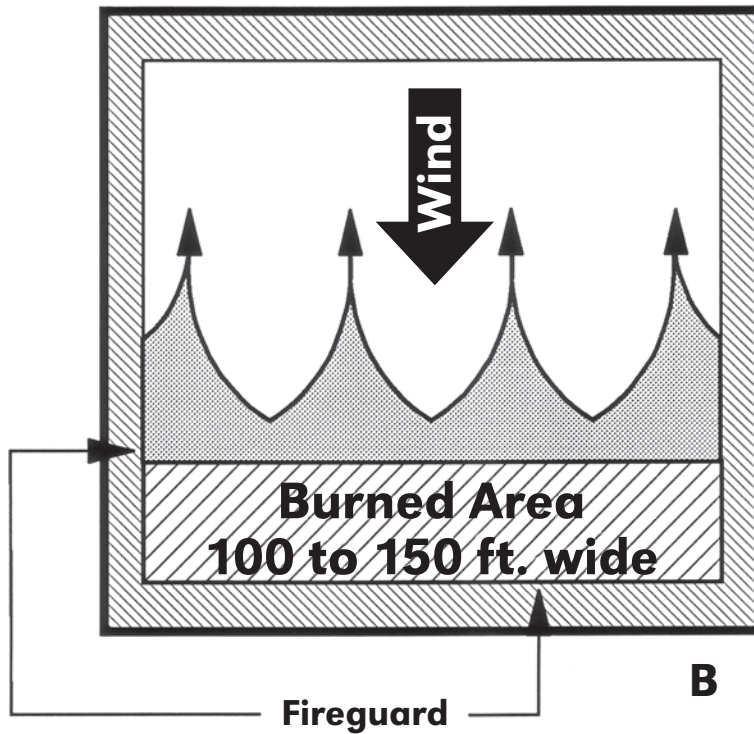


Figure 5A-B. Strip-headfire and flank fire ignition patterns. Direction of ignition is indicated by arrows.

The morning of the day of the burn, set a backfire along the downwind sides of the burn area inside of the plowed or disced firebreak. Backfiring should proceed slowly to ensure that flame lengths do not exceed the width of the fireguard and tall grass stems do not fall back across the plowed or disced firebreak as the lower portion of the plant burns. These stems can cross the firebreak and allow the fire to escape.

Once the fireguard along the downwind portion of the pasture has burned to a sufficient width (100 to 150 ft or 30 to 45 m) to ensure no fire escapes, the remaining portion of the area can be burned with a headfire.

An alternative approach is to disc a second line 100 to 150 ft on the interior and parallel to the perimeter lines. This interior line provides a stopping point for burning out the fireguard, and gives more flexibility for igniting the headfire. Also, the interior line alleviates concerns with running a headfire into a backfire, which can promote firewhirl development and increase risk.

Ignition Techniques

Both backfires and headfires are used in prescribed burning (*Figure 4*). A backfire backs into the wind, has a low flame height, is slow, and can be easily controlled. Backfires are used when a low-intensity fire is desired, such as when widening fireguards, burning high-volatile vegetation, or protecting brush piles, stream banks, water wells, etc.

In contrast, a headfire moves with the wind, has taller flames that are usually two to three times the fuel height, and generates a great amount of heat for a short period of time. Headfires are used when high intensity fires are required to meet burn objectives, such as top-killing trees or burning downed woody debris.

Fire behavior can be manipulated to meet desired objectives by using different ignition patterns (*Figure 5*). A strip-headfire and flank fire are used when a backfire moves too slowly and a conventional headfire would move too quickly to be safely controlled. Generally, a combination of backfires, headfires and flank fires are used during a prescribed burn.

Smoke Management

Smoke is a nuisance to those downwind and can be dangerous when it settles over roads. Plan to burn when the wind velocity and direction will carry the smoke away from homes, towns, airports, roads or other smoke-sensitive areas. Fire crew members must be positioned to direct or stop traffic if smoke carries across roads.

Burning when the atmosphere is unstable will help the dispersion and vertical movement of smoke. Atmospheric instability indications include clouds with obvious vertical expansion and good visibility. Obviously, burning during extremely unstable conditions is dangerous because fire behavior will be erratic. A stable atmosphere, on the other hand, restricts smoke movement. Under very stable conditions an inversion may develop (a layer of cool air between the ground and a layer of warm air). Clouds in layers, poor visibility due to haze, and smoke hanging near the ground indicate a stable atmosphere.

Personnel Requirements

Personnel requirements for a prescribed burn depend on several factors including 1) volatility of vegetation, 2) type of fireguards, 3) size of area, and 4) weather conditions. A seven-person crew can efficiently burn low-volatile vegetation on an area with established firebreaks. The fire boss supervises and coordinates all burning activities. This individual must be experienced in fire ignition and suppression techniques in the vegetation type to be burned, have good judgment, and be able to direct people in tense situations.

Of the remaining personnel, two will carry drip torches when widening fireguards and igniting the headfire, two will carry hand tools or backpack water sprayers, and two will operate the tractor and sprayer or truck and water pumper. In high-volatile fuels more people are needed to watch for fire escapes.

Notification of Neighbors

As a matter of courtesy and good relations, notify your neighbors of your intent to burn at least two to four weeks before the burn date, the date of the burn, and upon completion of the burn.

Prescribed Burning Checklist

Use the following checklist when developing a prescribed burning plan (*Figure 6*). While useful as a guide to prescribed burning, it is not a replacement for actual burning experience. This checklist will help in the evaluation of the burning objectives, weather conditions, fuel characteristics, and topographic situations under which the prescribed burn will be conducted.

Figure 6. Prescribed Burn Checklist.

Part 1. Area Identification, Objectives, Preburn Practices, Site Characteristics, and Desired Conditions (Complete 6 to 12 months before the burn.)

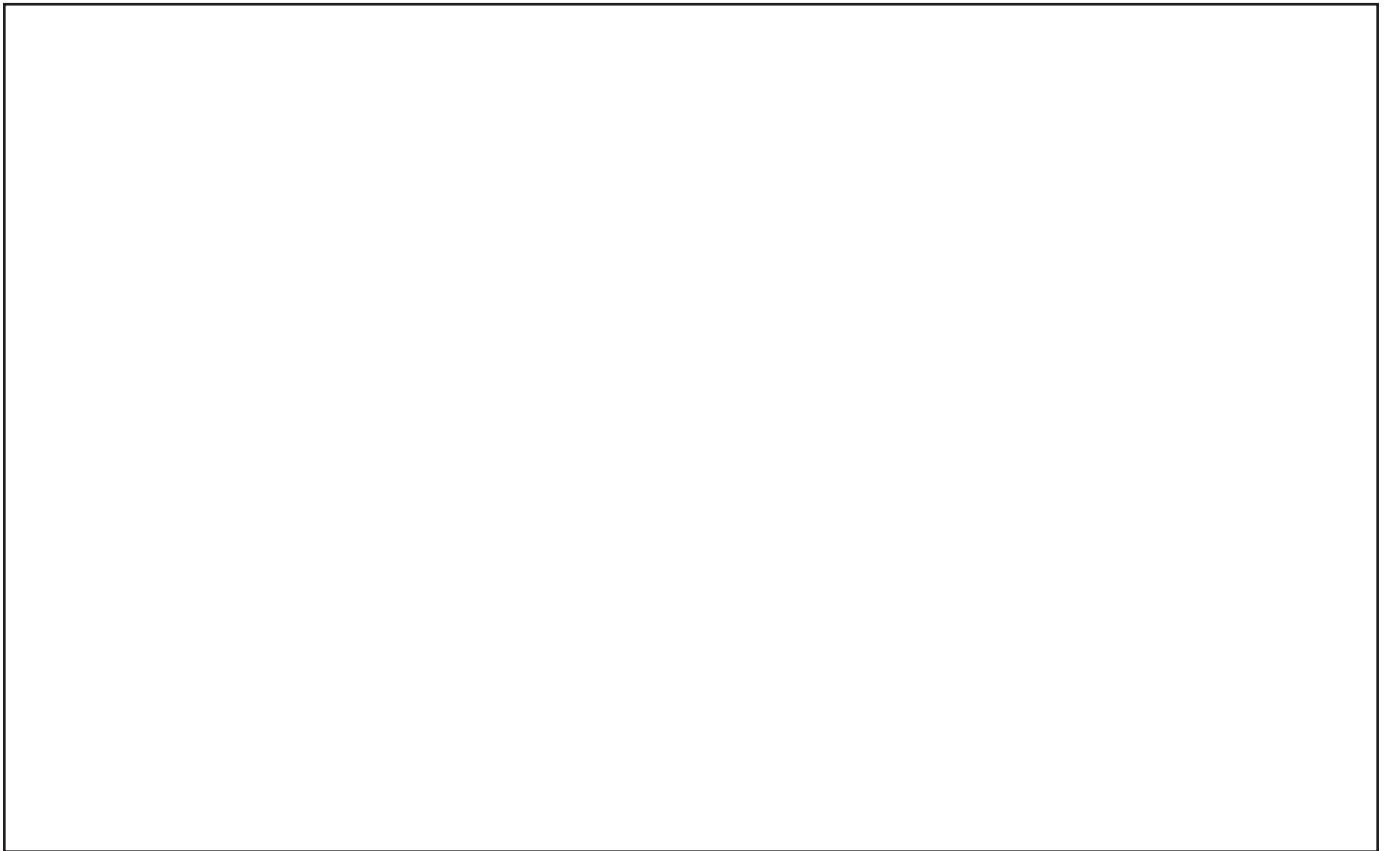
A. Area identification

Location of area _____

Size of area _____

Proposed date(s) of burn _____

B. Sketch of area to be burned



C. Objectives of the prescribed burn

- ___ Fine fuel reduction
- ___ Weed control — Target weeds _____
- ___ Forage improvement (yield, quality, palatability)
- ___ Wildlife habitat enhancement
- ___ Other

D. Preburn practices to increase fine fuel load

___ Grazing deferment

___ Herbicide treatment

Type, rate, and date _____

___ Mechanical treatment

Type and date _____

E. Site characteristics and desired weather conditions

1. Major fuel type (approximate percent cover of each)

___ Fine (grass, forbs)

___ Coarse (woody), low-volatile (i.e., honey locust)

___ Coarse (woody), high-volatile (i.e., eastern redcedar)

2. Slope

___ level to rolling ___ moderately steep ___ steep

3. Potential hazards (hay bales, oil or gas wells, windmills, heavy fuel accumulations, buildings, shelterbelts, roads, etc.)

4. Range of acceptable weather and soil moisture conditions

_____ Wind direction

_____ Wind speed

_____ Relative humidity

_____ Temperature

_____ Soil moisture

_____ Other (_____)

5. General remarks (location of water sources, points of access, etc.)

Part 2. Permits, Notifications, Equipment, Crew, and Emergency Assistance (Complete within one month before the prescribed burn.)

A. Permits

	Address and Phone	Contact	Issued
County	_____	_____	_____
Local	_____	_____	_____
Other	_____	_____	_____

B. Notifications

	Address and Phone	Contact
Fire Dept.	_____	_____
State Police	_____	_____
Local Police	_____	_____
Neighbors	_____	_____
Others	_____	_____

C. Equipment requirements

	Item	Number	Source
Burning equipment	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Safety equipment	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
Other	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____
	_____	_____	_____

D. Crew requirements

_____ Minimum crew size

	Name	Address and Phone
Fire boss	_____	_____
Crew members	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____
	_____	_____

E. Sources of emergency assistance

	Address and Phone	Contact
Fire fighting	_____	_____
First aid	_____	_____
Other	_____	_____
	_____	_____
	_____	_____

F. Fireguard construction

- _____ Plowed fireguard
- _____ Disced fireguard
- _____ Mow and wetline
- _____ Mow
- _____ Natural firebreak

Part 3. Fire Preparation Activities (Complete day before or day of the prescribed burn.)

A. Weather Forecast

National Weather Service telephone number: _____

B. Preburn discussion with crew

- _____ Objectives of the prescribed burn
- _____ Extent of area to burn
- _____ Communication (chain of command)
- _____ Tour of area to burn
- _____ Ignition pattern discussed
- _____ Smoke management plan
- _____ Check fireguards for adequacy
- _____ Use of equipment demonstrated and understood
- _____ Equipment in working order
- _____ Review special hazards (fuels, weather changes, topography, poisonous plants, firebreaks, etc.)
- _____ Worst-case contingencies (wind shifts, equipment failure, personnel injury, etc.)
- _____ Sources of assistance
- _____ How to get assistance
- _____ Proper clothing

C. Crew assignment

Ignition _____

Suppression _____

Directing traffic _____

D. Fire record

1. Date and time of fire initiation _____

2. Weather

Start of burn

End of burn

_____ Wind speed

_____ Wind speed

_____ Wind direction

_____ Wind direction

_____ Relative humidity

_____ Relative humidity

_____ Air temperature

_____ Air temperature

3. Soil moisture content

_____ saturated _____ moist _____ dry

4. Test fire behavior

5. Ignition patterns used

_____ Flank fire;

Where _____ Why _____

_____ Headfire;

Where _____ Why _____

_____ Backfire;

Where _____ Why _____

_____ Strip-Headfire;

Where _____ Why _____

6. Postfire activities

_____ Time fire extinguished

_____ Mop-up completed

_____ Equipment collected

_____ Final perimeter checked

_____ Local officials notified after fire is out

7. General remarks (fire behavior, weather changes, equipment problems, etc.)

8. Objectives of prescribed burn accomplished

_____ Fine fuel reduction

_____ Weed control, target weeds: _____

_____ Forage improvement (yield, quality, palatability)

_____ Wildlife habitat enhancement

_____ Other

Acknowledgement

This publication is a revision of the Extension Circular *Conducting a Prescribed Burn and Prescribed Burning Checklist* (EC121) by Robert A. Master, former Range Scientist, USDA-ARS, Robert Stritzke, former Extension Educator, and Steven S. Waller, former Professor of Rangeland Management.

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