Basic Fire Crew Primer

Introduction

This Primer is an introduction to prescribed fire for a general audience. Its purpose is to assist training of crew at a basic level, for conducting prescribed fire in various habitats such as grassland, oak savanna, woodland, or wetland. This instruction is not intended for fire in largely coniferous forests.

This document is a collaboration between three fire educators in southern Wisconsin: Robert Baller, Dan Wallace, and Jeb Barzen, with editorial assistance from Willis Brown.

We acknowledge two important fire organizations influential on this document.

The first is the Wisconsin Prescribed Fire Council, a non-profit group of experienced individuals who donate time and knowledge to promote safe prescribed fire. The board members are mostly prescribed fire professionals. The three contributors to this document are members. This Primer follows the WPFC list of topics ("Standards") for a one-day, basic crew training program. The WPFC Standards for different levels of fire crew may be found at their website.

The second is the National Wildfire Coordinating Group, a U.S. governmental agency tasked with training wildland fire responders. NWCG basic training includes instruction on the Incident Command System, which is the organizational framework used by emergency responders of all kinds.

In this Primer we will attempt to employ terminology acceptable to all fire organizations, and try to minimize difficulties where prescribed fire concepts may differ from emergency wildfire response concepts.

We remind the reader this is an introduction and refresher, and not a replacement for guided training and field experience. All fire is dangerous and potentially lethal.

Let us call this Version 1 of the Primer. We realize it may be incomplete, and we hope others will help us make it better. It was edited last on 2020-11-22. Please refer all comments to Rob Baller at <robertballer@outlook.com>.

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WHY BURN?

In the past, large regions of the Midwestern landscape were affected by fire, often set by Native Americans, or lightning. Midwestern ecology is believed to be broadly adapted to recurring fire, and fire is required for many wild species to survive. At the same time, fire may damage species alien to this region which have been introduced and have become invasive but which are not adapted to fire. These two aspects make the use of prescribed fire important over broad regions. Conversely, fire may also damage some native species, even fire-adapted plants, and animals, people, communities, or property, if conducted inappropriately such as at the wrong time of the year or under extreme conditions. Care must be exercised to promote maximum safety for people, and maximum benefit for the environment.

Prescribed fire is planned fire, deliberately set & managed. We use it in order to re-instate a natural process that is necessary for several ecosystems.

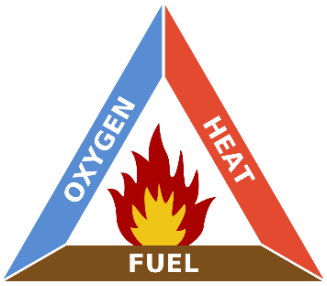
More broadly, prescribed fire is the planned use of fire, conducted by trained crew, in a safe sequence of actions, under specific fuel and weather conditions, in a specific area with prepared control lines, to achieve specific management objectives. Prescribed fire is a critical tool for helping restore landscapes to a natural condition. Examples of management objectives (which help determine why and when we burn) may include reducing woody growth, reducing certain species of invasive flora, preparing the field for herbicide application, maintaining rare insect or animal populations, or stimulating native flora seed production.

The emphasis of this document is on basic fire crew knowledge, and details of why we burn, or the effects of fire, are the purview of higher training, such as for burn boss and/or fire manager. In this Primer we will end our instruction of this topic here. Please consult other resources for further information on why we burn.

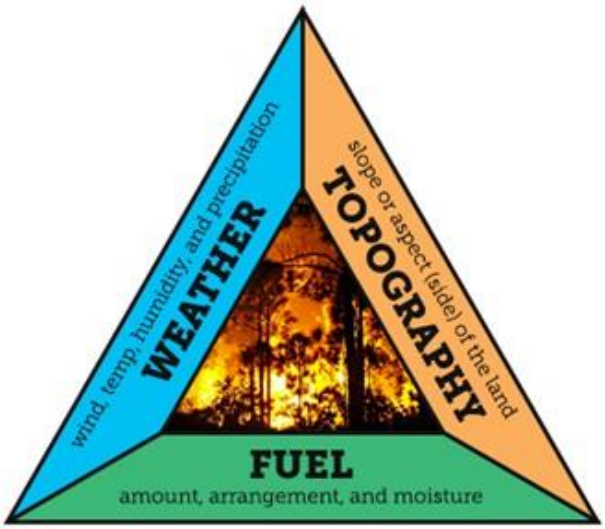
Basic Fire Crew Primer

1. FIRE BEHAVIOR

The **Fire Triangle** (right) displays three main physical components affecting fire: **fuel, heat**, and **oxygen**. Some teachers prefer to replace the term "heat" with "ignition source". We acknowledge both are acceptable and are part of fire. At the most basic level of understanding, fire crews attempt to control fire by manipulating the three sides of the triangle.



The **Fire Behavior Triangle** (below) is an aid for teaching about burning *land* because it addresses **fuel, weather,** and **topography**. These strongly interrelate and are sometimes affected by the fire itself. We discuss how those features relate to prescribed fire below.



Fire Behavior Triangle

Fuel

When burning land, all fuel is vegetation of some kind. In the Midwest, it is customary to describe these vegetative fuels as *fine* or *heavy*.

Fine fuels like grasses and oak leaves, react quickly to changes in atmospheric humidity. They absorb and lose water within hours of a change in relative humidity. Dry fine (or "light") fuels burn rapidly and release a lot of heat quickly. Fine fuels on fire can usually be extinguished rapidly with water.

Heavy fuels like sticks and logs, react more slowly than fine fuels to changes in atmospheric humidity. They require days, weeks, or months to absorb or lose water from the air. Heavy fuels may require considerable effort to extinguish once ignited.

Ladder fuels are flammable materials that provide fire a path from the ground to combustible aerial materials. Examples are dead vines, or flammable shorter trees (like balsam firs) that guide fire to the flammable crowns of conifers. Ladder fuels are not desirable on prescribed fires because once fuels are ignited up high, they can be troublesome to extinguish. Preparing the field before the fire, pulling down or isolating ladder fuels, will help avoid undesired ignition.

Moisture. Fuel moisture is a large subject and dependent on the kind of fuel as well as the weather and topography. We will provide only a few examples for description since this is a basic guide: fuel moisture is affected by the number of days since last rain; amount of rain; rain duration; sunshine/shade; temperature; relative humidity; type of fuel; and type of soil.

The type of soil is very important for fuel moisture; black or rich soil may hold so much moisture that it dampens fine fuels and depresses fire behavior to the point where the fire may not satisfy management objectives. Conversely, sandy soils dry quickly; vegetation may burn more readily and even green vegetation may burn surprisingly well, sometimes in midsummer, on sandy soils.

Grassy fuels that turn green quickly in spring, like smooth brome grass, or Kentucky bluegrass, have a high moisture content, and will produce not only cooler fire but lots of obscuring white smoke when green or wet.

Logs that are cool and moist from winter or from heavy rain may not ignite at all due to their high moisture. One may be able to burn around them and under them without igniting them, when the only truly dry fuels are tree leaves or grass.

Most Midwestern prescribed fire is conducted in early spring, after snow-melt but before significant green up, when fuel moisture is lowest. This is usually March-May.

As you might expect, fuel moisture and flammability are closely tied to atmospheric *relative humidity*, discussed again under Weather.

Arrangement (Distribution) of Fuels. Dry, fine fuels (grasses and oak leaves) that form continuous cover on the ground nearly always support flame spread. If there is strong wind and dryness, fire may spread despite the gaps. Heavier fuels like sticks or logs may ignite depending on the spacing between them, but usually only after they are heated by the finer fuels that carry the flame through the woods.

The effect of fuel distribution can be illustrated in the extreme where fire crew deliberately reduce fuels in order to control a wildfire. This is the basic premise behind any fireline, which is a strip of land cleared to contain a fire (NWCG).

Weather

Relative Humidity (RH) is the air's capacity to hold water. Relative humidity affects fuel moisture, and thereby the flammability of fine or heavy fuels, and fire safety. The relationship between relative humidity and air temperature is inverse: higher temperatures cause lower RH. A 20-degree warming of air temperature will cut the relative humidity in half. Drier air allows moisture to move from fuel to the air, drying fuel and making it more flammable, and moderating our ability to control fire or achieve management objectives.

The **desirable range** of RH for most prescribed fire in the Midwest is from **30 to 60% RH,** though prescribed fire can be conducted safely between 20 and 70%. If RH is lower than 20%, conditions may be too volatile for adequate fire control, and the fire may damage natural resources. If RH is higher than 70%, fuels may be too damp to burn properly to meet management objectives.

Precipitation. Grass may receive rainfall the night before, and with a little sunshine be dry enough to burn the next day. Woody fuels will require several days or weeks to become flammable after prolonged rain. Both the length of time since the last rain, and the amount of rain that has occurred, affect fuel moisture levels and flammability.

Temperature. The desirable air temperature range for prescribed fire is **32 to 80 °F**. Above this, fuel may be too flammable to easily control. Higher temperatures will increase the physical stress on the crew, who are working in protective clothing. Be wary of suppression equipment at freezing temperatures, as it may have water that is partly frozen, creating mechanical troubles.

Wind. Fire behavior changes instantly when the wind changes. Both speed and direction are important.

Desirable **wind speed** is commonly **3-15 mph in open grasslands, and 8-20 mph in woodlands**. Woodlands tend to block the wind; that is why higher wind speed is acceptable for woodlands.

Winds less than 5 mph are undesirable anywhere because they are "light and variable", *changing direction* easily. Fires generate their own heat and under minimal wind conditions that heat may alter the direction of flame spread, sometimes to the point where fires reverse course. This is why prescribed fires are usually not conducted if there is no wind at all. We require some wind to give us flame spread predictability.

Winds higher than 5 mph tend to be more stable in both speed and direction. Erratic or gusty winds are always undesirable because they are unpredictable.

Wind rarely blows a single **direction** and more likely blows from a range at any given time, such as south to southwest. Wind direction must be consistent enough so crew can anticipate fire behavior. If the wind is switching back and forth too much, the fire may be canceled. Wind direction is also critical for smoke management, such as avoiding smoke over a road, or sending smoke towards a residential neighborhood.

Wind direction always determines where the fire is started. For example, prescribed fires are most often started on the downwind side of the unit using an ignition technique that gives low flame lengths at first, called *backing fire* (discussed later).

Atmospheric stability.

Atmospheric stability refers to air movement **vertically** in the atmosphere, which in turn affects how the fire behaves on the ground.

Little or no upward movement is a **stable** atmosphere. Fires are easily controlled, but smoke may not adequately disperse (the heat and smoke do not have places to go).

Rising, vertical movement is called an **unstable** atmosphere. Smoke is transported up and away and fires tend to burn more aggressively. Instability can also become a watchout situation: too much atmospheric instability may cause turbulence and unpredictable fire behavior. We want a moderately unstable atmosphere for safe prescribed fire.

As a generalization, the morning atmosphere in spring and summer is usually *stable*. When the sun rises, it heats the ground, causing the air above the ground to rise. This upward movement of warmed air creates the instability that is common in the afternoon.

Normally the warmest air is near the ground, heated by the sun. When cool air is trapped near the ground (possibly producing fog) the situation is opposite and called an atmospheric **inversion**. Prescribed fire can still take place during inversions, but fires usually don't burn as well. Fires may send smoke to the neighbor's house in the valley rather than up into the atmosphere.

Topography

Topography is the configuration (shape) of the earth's surface.

Aspect is the compass direction that a slope faces. South and west aspects tend to be the driest due to solar heating, and that is where remnants of prairie are most likely to survive into modern times. North and east aspects are usually cooler and tend to grow trees and brush more readily than the south and west aspects. Consequently the south and west aspects tend to be more fire-prone.

Slope refers to the steepness of the terrain. Due to rising air, and the flames preheating fuels as fires move uphill, fires will usually move upslope the same as if driven by the wind on flat land. This is especially the case where steep valleys and/or saddles can funnel and/or intensify the fire and direct it rapidly uphill.

Fire usually moves slowly down slope. However, in all cases, fire behavior may be surprisingly modified by the wind, which may contradict expected flame direction, and sometimes drive the fire sideways.

Steep slopes are tiresome to climb. Frequently they contain loose rocks, unseen under leaves or dry grass, making footing unsure, even perilous. This can lead to safety issues especially for people in marginal physical condition.

Never position yourself on a slope above a fire.

2. BURNING TECHNIQUES

Types of Fire

The three "types" of fire are identified by their relation to wind direction, and/or movement on a slope.

Backing Fire is fire moving against the wind and/or downhill (NWCG). Backing fires have the shortest flame lengths (of the three kinds of fire), move the slowest, and consume fuel in a thin line. Their long retention time means they will scorch small trees and shrubs. Backing fires never leap backward.

Flanking Fire is fire consuming fuel in a line parallel to, or slightly oblique to the wind (WDNR). Flanking fires usually burn fuel faster than backing fires, have longer flame lengths, produce moderate smoke, and are susceptible to flaring and/or settling down with changes in wind direction.

Head Fire is fire that moves with the wind or upslope (NWCG). Head fires have long flame lengths, the most rapid rate of spread, they consume large amounts of fuel quickly and often ignite fuels covering a large expanse at once, and release tremendous amounts of radiant heat. One must never stand in front of a head fire.

Ignition Techniques

These are ways to deliberately control ignition, thereby influencing the rate of spread, smoke dispersal, and safety.

Test Fire. At the beginning of a prescribed fire, a small fire is lit to confirm that the conditions are acceptable for a controlled burn. The crew observes flame length, rate of spread, smoke dispersal, and general safety. If conditions prove favorable the burn boss will signal that the fire will continue. If conditions appear unfavorable, the burn boss may have the fire extinguished and possibly redeployed at another location. The fire might also be delayed if safer conditions will appear later, or it may be canceled for the day. An important term for the location of the beginning of the fire, which is where the test fire occurs, is **Point of Origin.**

Strip Flanking Fire is a small flanking fire (ignited in a line parallel to the wind) for widening a controlled burn-out within the unit.

Strip Head Fire is a head fire used to rapidly widen a burn-out inside the unit. The flame front will roll away as it is propelled by the wind. Strip head fires are lit close to backing fires so the two meet each other and finish quickly, keeping the head fire small enough so it will not cause spot fires beyond the firebreak.

Ring fire is a term for a sequence of ignitions that ultimately surround the burn unit with fire on all sides, and the various ignitions are purposely conducted and timed so that all fires draw inward at completion.

A ring fire nearing completion, showing convective heat drawing all fire to the interior. Conducted by volunteers of The Prairie Enthusiasts in Green County, WI. Photo by Jerry Newman.

Accidental Fires and/or Fires outside the Unit

Spot Fire is any small fire burning outside the unit. Spot fires are often caused by embers or fire brands, or by “slop-overs” which are places where fire crept across a control line (NWCG). Crew should be alert for this and when spot fires are found, notify others immediately (yell “SPOT!”)

If the spot fire is still small enough for a person to extinguish it, then do so immediately. If the fire has grown larger and requires more crew to control it, this must be communicated to the leaders, who will make rapid assessment and instruct how to redeploy crew in order to attack the spot fire. Some crew must remain with the prescribed fire while others are sent to attack the spot fire. Attacking crew should always approach the spot fire from the downwind side and work from an anchor point, usually a black area. Begin extinguishing the backing fire, then move along the flanks (preferably from inside the black

area, provided it is cool enough to permit entry) and finally pinch off the head. Crew members should never position themselves downwind of a spot fire.

If direct attack does not work the next recourse will be to consider creating a fallback control line, or contacting emergency authorities.

Spotting is the tendency to form spot fires, indicated by live embers (leaves or fire brands) rising out of the burn unit and continuing to glow red as they drift out of the unit. Spotting is most likely to occur when relative humidity is low (<30%) and conditions are already dry and volatile. Some fuels more easily cause spot fires than others. For example, cattails can cause spot fires to occur at two to three times more distance than other plants.

Embers that turn black when rising from the field are much less hazardous. All crew should make a habit of observing ash and embers as they rise, and watch for spot fires outside the burn unit.

Crown Fire ("crowning") is a fire that advances across the tops of trees or shrubs more or less independently of the surface fire (NWCG). Evergreens are much more likely to erupt into crown fires than deciduous trees. Isolated evergreens may burn rapidly ('candle') and self-extinguish. Groves of evergreens that catch fire in their crowns are difficult to control and are considered dangerous. As a result, prescribed fire in evergreen (coniferous) forests require different training than fire in deciduous forests or grasslands.

Fire whorls are tornado-like spirals of wind that spin flame upward. They are usually temporary, but may alarmingly throw obscuring dust into the air. Fire whorls seem most likely to occur when the burn unit is level, on calm days, and when some rise in topography or a block of trees causes the fires at opposing sides to travel toward each other (such as may happen on a ring fire). When the fires meet, they spin into a fire whorl. Fire whorls are undesirable because of their obscuring ash and dust, and because they may send live fire brands outside the unit.

Ring fires should be designed so that if fire whorls occur, they happen in the center of the unit where they can do no harm to crew or cause spot fires.

Dust devils are momentary twirls of air, usually owing to heat rising rapidly over a black zone immediately after a fire. They spin dust and ash but do not have flame, and they usually spin a few seconds before they die out.

Fire Suppression

The *ideal* fire prescription, rarely possible in practice but good for strategy, uses none of the available water. Fire would ideally be contained through a combination of well-trained crew using intelligent ignition, advantageous weather, well-prepared firebreaks, and skill with hand tools.

In the field it is likely that fire will be suppressed with water, distributed through backpack pumps, trucks and/or ATVs with small engines, tanks, and hoses. Suppression may be aided by hand tools such as flappers, brooms, and rakes. Some agencies enable their suppression by burning later in the day, so that evening coolness and dewfall helps extinguish the fire.

The strategy of burning later in the day, into cooler rather than warmer conditions, is an important technique for prescribed fire. Many escapes have occurred when the weather turned more volatile than forecasted. By burning later in the day, the chances of encountering drier than normal conditions are minimized.

More about suppression will be found under **Burn Crew Assignments**. Tools for fire management are described and illustrated near the end of this Primer under **Equipment**.

Firebreaks

A **firebreak** is a place where it is safe to light the fire.

Firebreaks may, but do not necessarily, stop fire. Firebreaks are zones of intentionally reduced fuel that are useful for starting ignition and burning to the interior of the unit. Inflammable places like rivers and plowed fields can be used, and firebreaks can be intentionally created by mowing, burning, digging, or raking.

Firebreak types include mineral soil, mowed grass, raked leaf litter, or an inflammable barrier such as a river, road, or parking lot. Firebreaks should be at least twice as wide as the height of the fuel so that fuel that is burning and falling into the break will not cross it.

Mowed breaks often allow fire to creep across them so they should be wider yet, perhaps 4x wider than normal breaks to allow time to notice tiny fire creeping on them.

It is always vastly preferable to have firebreaks as clean as possible, either raked free of clippings or cleared with backpack leaf blower. If a firebreak is raked **before** ignition, clippings should be moved **outside** the burn unit so buildup does not occur at the edge where it adds to the heat and makes it difficult for the crew.

A **wet line** is water applied to a firebreak immediately before ignition. This makes fire control easier and permits crew to stay further away from heat once ignition begins. Often the igniter and wet liner work as a team, with the wet liner spraying first, and the igniter following and immediately lighting right next to the wet line. Do not apply water too soon with this technique, or some may evaporate before it is useful.

A **foam line** is foam applied to firebreaks before ignition. Foam is created by mixing an additive into the jet of water as it sprays. Foam dampens the fuel and suppresses fire longer than water alone, but it is not uncommon for fire to creep under a foam line and bridge to dry fuel outside the burn unit.

A **black line** is a firebreak prepared by burning away a strip of fuel, then extinguishing all flames. This technique permits crew to return later to conduct the rest of the fire at their discretion. Burning a back line can be done in places where other fire break preparation cannot be accomplished, such as steep slopes, rocky areas, or wet areas.

Black lining around a burn unit at the International Crane Foundation, Baraboo WI. This carefully guarded fire is about to be extinguished, and the burn unit (to the left) will be ignited another day. Note it is evening. Humidity is rising and wind is dying down, making safer conditions for this method. Photo by Rob Baller.

Mop-up

Extinguishing smolders after a fire is completed is called "**mop up**". Grass fires tend to burn themselves out 10-20 minutes after the main fire is completed, and usually little mop-up is needed, unless there are old stumps or wood in the field. Woodlands nearly always have smoldering hollows in trees, or dead limbs, that must be addressed via tools (axe, Pulaski, McCloud, chainsaw) and/or by dowsing with water. Dirt may be rubbed into branches or tree bark to snuff out fire on trees. Foam is very useful for suffocating smoldering wood. Wisconsin law requires all fire be extinguished before leaving the site.

3. BURN CREW ASSIGNMENTS

Hierarchy / Chain of command / Importance of following instructions.

A hierarchy is part of the National Wildfire Coordinating Group (NWCG) effort to harmonize emergency responses. On Midwestern prescribed fires also, leaders & crew work together, each with their roles & skills, to conduct a fire safely. A hierarchy reduces confusion when sudden decisions have to be made. The **chain of command** implies a hierarchy where personnel communicate only with the level immediately above or below them. This reduces cross-chatter and confusion.

Prior to ignition, the leaders and crew must join to discuss the burn plan, its options and safety measures, and answer doubts to the plan. **Once the fire is started**, **it is vitally important that all crew respect authority and respond quickly to the decisions of their leaders.** Active fire is no longer a place for democracy.

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Fire Leader / Burn Boss

The **burn boss** is responsible for carrying out the burn plan, and is ultimately responsible for the whole crew. The burn boss communicates directly with the line bosses. A burn boss settles indecisions. Burn bosses do not labor but observe the entire project as it proceeds.

Squad Boss / Line Boss / Crew Leader

The **squad/line/crew/boss/leader** directs and coordinates the line (the fire crew). This leader is responsible for the safety and well-being of their crew. There are usually at least (2) of them because fire is so often conducted by at least two crews traveling opposite directions around the burn unit. The line boss assigns tasks to their crew members. The span of control suggests that no leader should have more than 5 direct reports.

Though two crews and two crew leaders are the typical situation, it is common to have three crews where the third group is an internal ignition squad. The third group will have a leader also. Internal ignition may be planned in order to protect structures inside the unit, or protect an island of unburned refugia. This would be most likely on larger (>20 ac.) units.

Fire Crew Members

(You!) are given assignments by the line boss. There are many roles.
A **spotter** is usually someone outside the burn unit, across the firebreak, with two-way radio watching for spot fires. A spotter should have suppression equipment on hand. A spotter may be either stationary or roving.
A **lookout** with radio, may be stationed at some high elevation to observe the entire burn and watch for troubles. Often the roving burn boss serves as the lookout.
An **igniter** spreads fire according to the directions of their line boss. The igniter has a dual responsibility in that they should pay attention to the line boss, but also observe the crew, who must now react to the fire and smoke just lit. An igniter should conserve torch fuel to the extent possible, and inform the line boss about the level of resources remaining.

The rest of the line crew are team players assigned some level of suppression responsibility, either with back cans, hand tools, or water hoses from vehicles.
If there are **water trucks**, one crew member will drive and another will operate the hose. Both must know how the apparatus works, be able to adjust the speed and restart the pump. Both must **monitor** the **water level of the tank** throughout the burn. Both must agree upon **hand signals** before the fire, for advancing, backing-up, and stopping. (Pumps tend to be loud and interfere with voice communication.) Care must be exercised when backing any vehicle so as not to run over a hose, equipment, or a person.

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4. FIRE PLANNING

Fire Prescription / Burn Plan

A **burn plan** (or "fire prescription") is a written document describing all conditions that must be met for the burn to proceed. It describes what is to be accomplished (the objective) and commonly includes a description of the burn unit, a map or aerial image, weather conditions, crew size, firebreak information, equipment needed, neighbors, hazards, smoke consideration, emergency information, and contacts for approval authorities (911 dispatch, local fire chief, WDNR fire ranger, etc.). Burn plans are one means of communicating all intentions to others involved. They compel a complete planning process by visiting all the considerations. Burn plans are prepared by a burn boss or higher-level supervisor.

Go-No-Go Checklist

Prior to any ignition, the burn boss will review and fill out a list of conditions that must be met for the burn to proceed. These may include: all weather parameters are favorable; all personnel are on site; all approvals and permits are obtained; an adequate burn map has been provided; medical facilities have been identified and emergency actions discussed; all personnel are briefed on their assignments, etc.
After Action Review. After the fire is completed, and when crew are waiting for smolders to finish, is a good time to review what went well and what could be improved. All crew are involved and all comments should be welcome. The discussion is usually led by the burn boss.

Protective Attire (Personal Protective Equipment or PPE)

Attire. Burn crew shall wear **natural fiber** clothing such as cotton (denim), wool - or - fire-resistant (**aramid fiber** such as Nomex brand) coveralls, shirts & pants. Pants and shirt sleeves must be long and without frays; *frays catch fire*. **No synthetic** clothing is allowed, such as wind breakers or stretch caps of polyester, nylon or rayon.
Leather g**loves** are required. Cotton gardener's type gloves are *not* sufficient for picking up burning sticks.
Leather boots are required. They shall be 8-inches tall minimum, with sturdy hard rubber soles. Cleated soles are important when working on slopes; smooth soles are too slippery on slopes. Steel-toed boots are acceptable.
Caps are required. They protect hair from fire. Cotton or wool caps are acceptable. Remember to tie long hair up and hide under clothing. Hard hats are **strongly recommended** when available, especially in forest communities. Hardhats are advantageous for more than just impact protection; the suspension inside them separates skull from heat and provides superior heat protection to baseball or stretch caps.
Eyewear of some kind is required. (Safety glasses, sunglasses, prescription glasses, goggles, face shield.)

Safety

The following terms and concepts are from the National Wildfire Coordinating Group.

LACES. Acronym for: **Lookout; Anchor Point, Communication; Escape routes; Safety zones**.

On any given fire, someone may be assigned the duty of **lookout**, to watch for problems while tracking the progress of the entire fire. On many Midwestern fires this will be the burn boss. It is equally

important that the “Lookout” expression refer to all crew members being constantly on the lookout for potential problems.

In prescribed fire, an **anchor point** is an advantageous geographic location where an attack on an escaped fire can be safely initiated. This is most often an already-burned area or a fire break, but it can also be a fire-safe feature like a lake, a wide road, parking lot, or a bare farm field. An anchor point is used to minimize the chance that active fire would trap or overrun crew attacking the escape.

Some form of absolutely reliable **communication** is required. On most Midwestern fires, two-way radios are the rule, along with voice instruction. Communication also implies that crew are expected to ask questions and receive answers from their leaders. Crew **must** know what is expected of them.

Escape routes are safe pathways away from the fire or future fire. They must be inflammable and must not pass on the uphill side of flames. Escape routes are constantly changing as the fire progresses. All crew are expected to re-evaluate their escape routes as the fire proceeds. Escape routes must lead to anchor points or other **safety zones**, which are places that are inflammable. Acceptable safety zones may include parking lots, roads, dirt fields, or the newly burned black area once it is large enough and it has cooled a few minutes.

Watchout situation is a potential danger in the field. Examples include: winds that change speed or direction suddenly; temperatures *increasing* and relative humidity *decreasing*; frequent spot fires; lack of communication about safety and contingency plans; unburned fuel between you and the fire.

Situational awareness means remaining aware of your surroundings. There is a very natural tendency to pay attention to the problem (or splendor) in front of us. Crew must remain vigilant of the surrounds. Look up, look down, look all around, keep your head on a swivel. Pay attention to the wind, the rate of fire spread, your escape routes and safety zones, and the actions of all crew.

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5. EQUIPMENT

1 2 2 3 4 5 6

1. Drip torch. A hand-held canister containing fuel for igniting the field. The long, hollow tube with drip pad drips burning fuel onto the ground. A loop in the tube prevents oxygen (and fire) from traveling into the can. A valve on the can allows air to enter as the fuel leaves. Fuel mix is typically 3-parts diesel and 1-part gas, but variations may be used.

2. Backpack pumps. 5-gallon reservoirs worn over the shoulders, carrying water, for suppressing fire. Metal and collapsible fabric models are available. Water is squirted through a 'trombone' slide hand pump. The slides have two nozzle options that can be changed in the field, a single hole for long distance and fine stream, and a double hole for shorter distance and broader spray. Check local crew practices on nozzle preference; some crew want only the single-hole nozzle used so all packs are consistent.

3. Flapper. A heavy rubber sheet, appearing like a truck mud flapper on a hoe handle. The flapper is moved over flames slowly to smother them. Swatting with the tool rather than smothering is usually forbidden as it may scatter flames. Also, flappers held stationary too long will melt. Useful on low fuels, such as short grasses.

4. Broom. These are flat-bristle fire brooms, preferably soaked in water overnight before the burn. The fire broom is lightweight and useful for sweeping loose fuel into the black, thereby extinguishing small flames and smolders.

5. McLeod. A broad, heavy rake head on a solid wooden handle. One side has teeth, the other is a blade. Useful for scraping soil and dragging heavy fuels.

6. Pulaski. A special firefighter's tool, a combination axe and adze or hoe. The head is mounted on a solid wooden handle. Useful for chopping, scraping ground, tree bark, and dragging heavy fuels.

Rake. (not shown) Metal-tined leaf rakes and the heavier steel garden rakes, with wooden handles, are useful for extinguishing fuels (especially oak leaves) by dragging them into the black, thereby scattering and/or suffocating them. Alternately, either may be used, judiciously, to drag flaming leaves and spread the fire. Rakes with plastic will likely melt. Very heavy steel rakes such as used by roofing and asphalt workers may also be used, and they will last longer than garden rakes.

Motor Vehicles. Vehicles are of many sorts: truck, ATV (3-wheel), UTV (4-wheel), and sometimes trailers pulled behind any of them, each with their own fire suppression equipment which must be reviewed prior to field work. Gas or electric pumps may be used for water delivery; sometimes both are on the same vehicle with one as the primary and the other as backup. Water tanks range from 40-300 gallons.