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Ground Ignition Test Results



Ground Ignition Test Results



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Some of the materials described in this publication are available in metric sizes; others are available in English sizes. Sizes in parentheses are conversions. For instance, a 2 1/2-inch (63mm) fitting is available in English sizes, not metric.

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Introduction

After the Missoula Technology and Development Center (MTDC) published “Ground Ignition systems: An Equipment Guide for Prescribed and Wild Fires” in 1993, field personnel requested more detailed information on applications for many of the listed devices. To fill that need, MTDC evaluated eight previously reviewed devices and two new ground ignition systems during FY 1994 to determine their range, accuracy, burn times, availability, and costs.

Three broad categories of devices were examined:

Hand-placed or thrown devices:

- Solid fuel firestarters
- Fusees
- Gelled gasoline packets

Ground torches:

- Diesel-powered flame throwers

Hand-held launchers:

- Signal pistols, 12 gauge
- Signal pistols, 25 mm
- Flare launchers, 37-mm rifle and 37-mm pistol
- Flare pens
- Fusee launchers
- Slingshot launchers

Project personnel contacted suppliers and manufacturers to request availability, equipment information, and price updates. The devices were evaluated to determine information and type of tests needed.

Tests were conducted on a level, graveled area on hot, dry days. The equipment was examined for technical functions. Devices were ignited only if it was safe, given the extreme fire danger in 1994. The balance of the equipment was subjected to dry-run testing. None of the devices was fired under actual field conditions.

Each of the selected systems was subjected to at least five trials to determine effective distance, length of burn, operational and safety tips and other applicable information. The results of those tests are discussed in this report and are summarized in Table 1 on the following page.

Table 1.—Ground ignition systems test for fiscal year 1994.

DEVICE	COST	AVAILABILITY	BURN TIME	RANGE	ACCURACY ¹
Solid fuel firestarter	\$0.25	Common	2-30 min	Immediate	Moderate to Excellent
Fusees	\$0.61-2.15	Common	Rated 10 min	0-100 ft	Good to excellent
Gelled gasoline packets: Supplies Sealer	\$0.50/pack \$635	Fuel common. Packets handmade. Order bags, thickener, cord, and sealer.	2-3 min per 100 gr	0-45 ft	Moderate to excellent
Power flame thrower (diesel): Fuel Unit	About \$1.30/gal No longer made	Fuel common No longer made	Varies with use	12-15 ft	Moderate to excellent
Flare pen: Standard fusee cartridge Standard fusee pen Skyblazer Military cartridge Military launcher kit	\$1 Less than \$15 \$4.13 each \$1.70 \$11.44	Difficult to find Difficult to find Common Order from military Order from military	Not tested 8 sec* 6 sec	Not tested 500 ft vertical* 600 ft plus	Not tested Fair Fair to moderate
Signal pistol: 12-gauge cartridge 12-gauge pistol 25-mm cartridge 25-mm pistol	\$2.25 Less than \$15 \$7.95 Less than \$60	All four items. May be difficult to find— some can be ordered.	5 sec 3-5 sec	280-320 ft 380-450 ft	Good Good
37-mm flare launcher: Cartridge Pistol Rifle	\$3.50 \$34.95 \$199	Order all three. Some supply problems w/Nova. Not recommended.	Starburst: 1 sec Nova: 5 sec	160-300 ft 155-225 ft	Moderate
Fusee launcher: Fusees Caps Unit	\$0.61-2.01 \$0.04 Less than \$800	Common Order Must be built	Rated 10 min	170-450 ft	Poor
Slingshot launcher: Spheres Glycol Syringe Needles Slingshot	\$0.15 Less than \$5 per gal \$0.80 \$0.25 \$9-12	Order Common Common Common Common	2-3 min	140-170 ft	Moderate

* Information supplied by the manufacturer.

¹ Excellent = On target
 Good = Within a few ft (about 1m)
 Moderate = Within 20 ft (about 6 m)
 Fair = Within 50 ft (about 15 m)
 Poor = Erratic





Hand-Placed or Thrown Devices

Solid Fuel Firestarters

Items tested included three brands of wax-impregnated sawdust blocks, petroleum-based fuel packets, and a petroleum-based gel as shown in Figure 1. The firestarters are commonly available under a variety of names at local outdoor stores, generally costing less than 25 cents each. A tube of gel that will light one to two dozen small fires costs less than \$4 retail.



Figure 1.—Solid fuel firestarters.

The items were placed on a level surface and ignited when dry and after being submerged in water for 60 seconds.

The wax products took patience to light and the flame took a while to build intensity. The flame was moderate but consistent, lasting 2 to 30 minutes once ignition took place (Figure 2). For the blocks that had been submerged, water on the surface had to boil away before the block began burning with a full flame. Because of their low fire intensity, the blocks would work best in fine fuels. Wax and wood residue products left little or no residue once burned.

The petroleum-based products lit easily, producing a hot flame quickly. The packets burned intensely, the fuel melting and dripping, causing a coating action that would assist ignition of surrounding fuels (Figure 3). The petroleum gel, although it ignites and burns rapidly, needed to be applied heavily or in several batches before igniting surrounding fuels. These products burned with a heavy petroleum odor and left an oily residue once consumed.

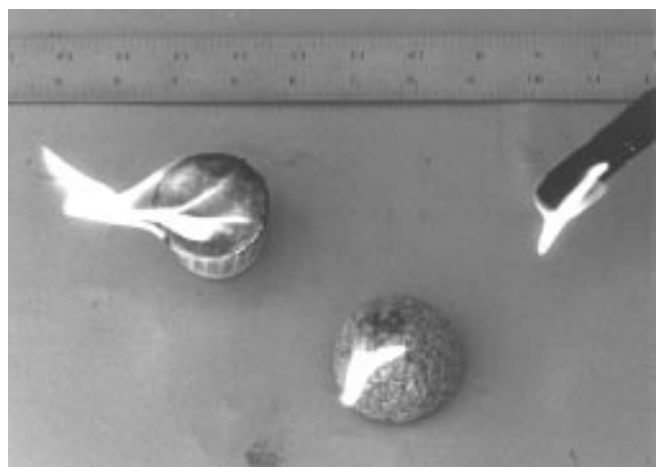


Figure 2.—Wax products on fire.

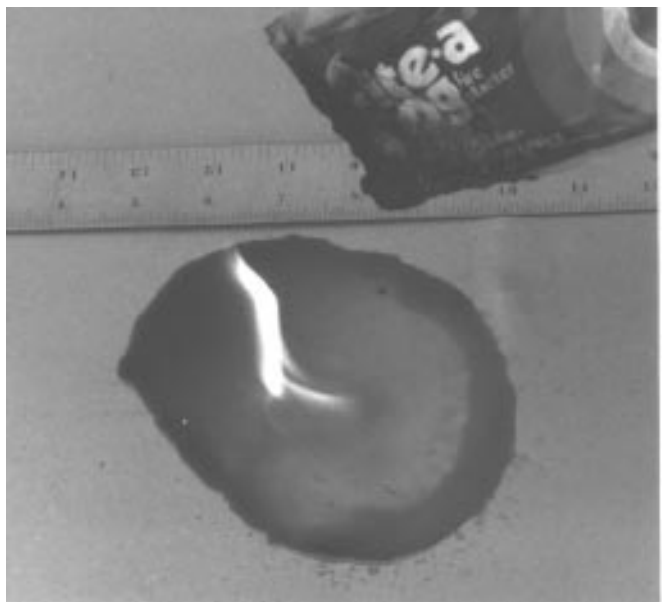


Figure 3.—Petroleum-based product on fire.

All three types of products are easily carried, inexpensive, and resistant to moisture deterioration. Of the three, the petroleum fuel packets were the most promising because of their coating action and the amount of heat produced. Accuracy is excellent if the packets are placed by hand.

Fusees

Ten-minute fusees (Figure 4) were subjected to dry-run testing. The fusees were tossed by hand. Fusees are commonly available or can be ordered from General Services Administration (GSA). Prices vary from 62 cents to \$2.01 each. Marine flares tend to be higher priced on the general market. Fusees are now considered explosives 1.4G and are subject to a shipping surcharge and other hazardous materials (Hazmat) restrictions.



Figure 4.—Assorted fusees.

Effective throwing distance was 90 to 110 feet (27 to 33 meters). In field use, fusees are lit, held for 5 to 10 seconds to ensure ignition and tossed while flaming (Figures 5 and 6). They may quit burning in midair. About one in three tend to bounce upon impact, extinguishing the flame or breaking the tube in pieces, reducing the burning time. Accuracy is excellent if the fusees are placed by hand, moderate if they are thrown.

Burned in place, fusees tend to produce an intense flame (1700°C) for about 1 minute, burning less intensely (700°C) for about 9 minutes afterward. They are suitable for igniting fine fuels.

Gelled Gasoline Packets

These plastic bags are filled with a gelled gasoline mixture, sealed, and tied with a slow-to-medium speed outward burning fuse called igniter cord (Figure 7). The packets are made by hand, costing less than 50 cents each, not including the price of the sealing machine (about \$635, plus shipping).



Figure 5.—Hold fusee....



Figure 6.—Then throw.



Figure 7.—Gelled gas inside bag, with an outward-burning fuse.

The packets were tested using 8.7 grams (0.31 ounce) to 800 ml (0.85 quarts) of Fire-Gel brand thickener mixed with unleaded gasoline. The thickener takes a long time (up to several hours if the fuel temperature is cold) to congeal.

Once gelled, the gasoline was placed in 2.7-mil plastic zipper bags, wrapped with an 18-inch (45.7-centimeter) fuse and burned in place. The fuse cord ignited readily, taking about 25 seconds to ignite the bag of fuel. The fuel burned intensely for an estimated 2 to 3 minutes per 100 grams (3.53 ounces) of gelled mix (Figure 8). The packets are suitable for medium to heavy fuels.

While burning, the packets produce strong gasoline and plastic fumes. The fuse itself did not completely burn, requiring that leftover wire be picked up and thrown away. An oily black residue was left behind, along with occasional pieces of plastic packaging. Gelled fuel requires special training, handling, and personal protective gear due to the intense burning potential. Even in small quantities, this product must be handled with care.

Dry-run tests were conducted to determine the effective throwing distance for the packets. The bags were placed on a shovel and tossed overhand and underhand. The effective throwing distance was 35 to 45 feet (10 to 13 meters), with

moderate accuracy. The bags occasionally bounced on impact. The seams and seals on the bags split, causing the fuel to disperse. To remedy this, use thicker bags (7 mil) and a commercial sealing machine.



Figure 8.—Gelled gas burning inside bag.





Ground Torches

Power Flame Thrower

The flame thrower tested consists of a gasoline-powered engine that pumps diesel fuel through an open flame on an eight-foot (2.44-meter) wand (Figure 9). The fire ignites the vapors surrounding the jet, depositing flaming oil on materials to be burned. A residual deposit of oil remains to sustain ignition, making the flame thrower suitable for medium to heavy fuels.

We tested the diesel-fueled Forester Power Flame Thrower Model #4220, by Western Fire Equipment Company. This version is no longer manufactured, but other similar models are still used by many USDA Forest Service units. This type of equipment is also available in gelled-fuel models at prices ranging from \$4,000 to \$18,700 for a complete system.

The test model, running on undiluted diesel fuel, projected flames 12 to 15 feet (3.66 to 4.57 meters) at a pressure of 100 psi (70,300 kg/m²). The fuel can also be diluted with kerosene or gasoline, producing a hotter flame. For

pressures of 125 psi, (88,000 kg/m²) flames can be as long as 20 feet (6.10 meters), resulting in moderate to excellent accuracy.

The wand must be preheated or it will stop burning between trigger bursts. Soaking the wick in diesel fuel is helpful. The most effective way to use the wand appeared to be applying flame in bursts to the base of fuels, while slowly waving the wand back and forth. The trigger is an on-and-off operation. No variable speed operation is available. Tests corroborated the manufacturer's estimate that the unit, if run intermittently, uses about 20 gallons (75 liters) of fuel per hour.

Fuels can be prepared by using the extinguished wand to spray pressurized diesel fuel on the vegetation. Then the wand is lit and passed over the prepared site.

This equipment requires three or four persons in addition to the regular fire crew: one to handle the nozzle, one to guide the hose, one to run the pump, and one to drive the vehicle. The power flame thrower also requires special training and

practice to use safely. The operator must pay careful attention to wind direction and drift while applying flaming fuel. The equipment produces large amounts of flame and heat quickly, and can tire an operator in a short time. Use face and neck protection. Light the wand with a long-handled piezoelectric lighter. Rotate operators and persons guiding the hose. Check fittings frequently to be sure there are no leaks that could start secondary fires or burn workers.



Figure 9.—Power flame thrower.





Hand-Held Launchers

Flare Pen

The flare pen (signal flare) is a small cylinder unit fitted with a trigger device for launching miniature signal flares (Figure 10). This device is available in commercial and military models. Signal flare cartridges are considered explosives 1.4G, and are subject to a shipping surcharge and other hazardous materials (HazMat) restrictions.



Figure 10.—Military flare pen.

Military MK 31 signal launcher (flare pen) cost is \$11.44 for a kit that includes a launcher and seven cartridges. Refill MK 80 hand-fired signal cartridge sets of seven are \$1.70 each. The launchers are only available in the kits.

The military flare pens are reusable metal cylinders not much larger than a stubby pencil. The spring-loaded trigger can be primed before use. A lanyard is supplied for carrying. The cartridges are about 2.25 inches (5.72 centimeters) long, packed seven in an easy-to-carry strip. These flares shoot about 590 feet (180 meters) horizontally, with a high-intensity flare lasting about 5 seconds, making them suitable for igniting fine fuels. Flare pens have been successfully used as a backfiring tool in fine fuels. Accuracy is only moderate because the flare pens are not easily aimed.

Commercial versions of the flare pen include the Skyblazer Red Marine Aerial Flare (XLT), a self-contained, single-use launcher and flare combination that comes packaged three to a blister card for \$12.39, dealer price (Figure 11). Variations of this type of device are available from marine



Figure 11.—Commercial flare pens and a military-style flare pen.

suppliers. Marine flares formerly available from Kilgore Corporation and Olin are now handled by distributors for Standard Fusee Company. As of fall 1994, local offices of the Forest Service were not able to order directly from Standard Fusee, but must order through the company's area distributor.

The Skyblazer XLT flare, which has the appearance of a short emergency road flare with a plastic handle, is designed to shoot 500 feet (153 meters) high with an 8-second burn at 40,000 candlepower. The top is pressed to release the flare and then pulled down to lock. After the cap is unscrewed, the unit is held above the head. A dangling chain is pulled to launch the flare. In tests, the flare's range was 460 to 590 feet (140 to 180 meters) when fired horizontally. Burn time was about 7 seconds. The signal flare burned with an intensity appropriate for igniting fine fuels. However, due to its cost and its one-time use, the Skyblazer XLT flare is not recommended.

Signal Pistol

Also known as a verry gun (Figure 12), the signal pistol comes in two sizes, 12-gauge and 25-mm. These items were originally developed as marine rescue equipment. They are designed to send a signal flare about 500 feet (152 meters) high. A plastic version of the 12-gauge pistol is available through Standard Fusee distributors for about \$13.10. Cartridges are \$2.25. The 25-mm pistol, which is manufactured overseas, can be difficult to obtain. Some forests report a price of \$54.60 per pistol and \$5.20 for each cartridge, purchased in bulk. Signal cartridges are considered explosives 1.4G, and are subject to a shipping surcharge and other HazMat restrictions.



Figure 12.—Twelve-gauge and 25-mm signal pistols.

The 12-gauge pistol tested had a horizontal range of 280 to 350 feet (85 to 106 meters), the 25-mm pistol had a range of 370 to 450 feet (112 to 137 meters). Shots at relatively flat (10- to 20-degree) angles resulted in longer and more consistent distances. The cartridges bounced when shot horizontally on flat ground.

The 12-gauge shells ignited in the air and stayed lit for about 5 seconds. The 25-mm shells did not light consistently during testing. Three out of five shells were duds. The rest burned from 2 to 5 seconds.

The 25-mm pistol was designed for occasional operation. When firing frequently, care must be used to keep the firing pin from bending. Operators need hearing and eye protection for continuous use. Aluminum slugs left from the flare may be hot to the touch for some time, and should be picked up, along with leftover casings. The plastic cartridges are not reloadable. Of all the launch devices tested, the pistols have the best accuracy, producing good to excellent results. Signal pistols are best used in fine fuels. However, they may be suitable for igniting some moderate fuels.

Flare Launcher

The 37-mm flare launcher is designed for repeated use as a signaling device, sending a pyrotechnic cartridge of black powder up to 500 feet high. A relatively new product, it is available both as a rifle and as a pistol (Figure 13) with two different cartridge styles, Starburst and Super Nova. The pistol costs \$34.95 and the rifle costs \$199. Cartridges cost \$3.50 each. Signal cartridges are considered explosives 1.4G, and are subject to a shipping surcharge and other HazMat restrictions.



Figure 13.—Both 37-mm flare launchers.

So far, Starburst cartridges have been readily available when ordered. They produce a 1-second flame similar to children's "sparklers." If the launcher is aimed too high, the flare's tiny sparks extinguish before hitting the ground. The most effective angle for sparks reaching the ground was between 10 and 20 degrees, which also resulted in the most consistent distance (a range of 155 to 185 feet, or 47 to 56 meters).

Super Novas travel farther than the Starburst before igniting, typically falling on the ground while still lit and remaining lit through bounces and rolls. The 5-second burn is much more intense than that of the Starburst, resembling a fusee.

Distance and angle results were less conclusive with the Nova. Medium and low shots (10 to 30 degrees) resulted in a range of 210 to 300 feet (64 to 91 meters). The 10-degree shots resulted in more bounces and rolls. High angles (40 degrees) resulted in shorter distance (160 to 240 feet, 48 to 73 meters) and bounces and rolls of up to 50 feet (15 meters). Side-to-side variations of 35 feet (10 meters) from center were recorded.

The rifle and pistol appear to have similar range. If anything, the rifle may have less range due to the resistance of the long barrel and tight fit of projectile. Both pieces demonstrate moderate accuracy. The pistol is recommended over the rifle because it is less expensive and easier to use.

Cartridges, wads, and other residues that are not burned in the ensuing fire will need to be properly disposed of. The residues may be hot for some time after being extinguished. The plastic shells are reloadable.

Both 37-mm flares showed a high dud factor (as high as 50 percent) in the tests, a situation that has not improved from lot to lot. This problem was judged to be quality control by the manufacturer and the method used to construct the flares. Because of this problem and the unit's high cost, this device should not be considered for backfiring.

Fusee Launcher

The device consists of a compressor unit attached to a gun barrel on a tripod (Figure 14). Fusees are manually fitted with a bore-sealing cap to conform tightly to the chamber (Figure 15). The unit has a manual trigger that releases the air behind the fusee when sufficient pressure has built up, forcing the projectile out the bore.

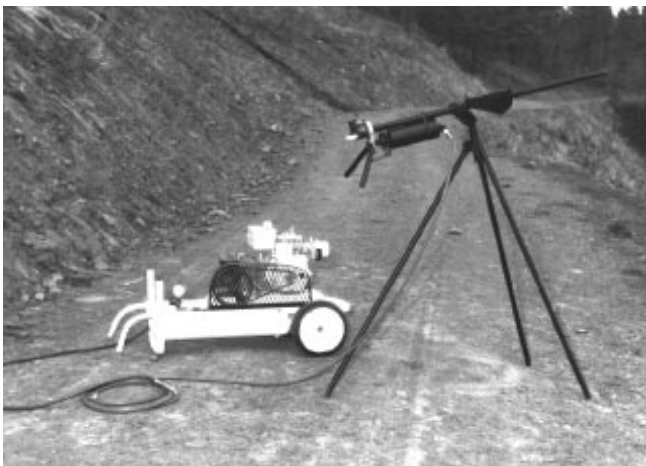


Figure 14.—Fusee launcher and compressor.

The fusee launcher was built for about \$800 from drawings developed by MTDC. Fusees are commonly available. They can be ordered from GSA. Marine fusees tend to be higher priced on the general market. Individual prices vary from 61 cents (GSA) to \$2.01 (commercial) for the 10-minute variety. Bore sealing caps are about 4 cents each. They can be ordered from hydraulic suppliers.

During testing, fusees were launched at 15-, 30-, 40-, and 45-degree angles at maximum pressure of 100 psi (70,310 kg/m²). An experienced operator and assistant could shoot about one or two fusees per minute from the bed of a pickup truck. The rate depends on the time needed for air pressure to recover.



Figure 15.—Plastic bore sealing cap for fusees.

The 15-degree shots had a range of 90 to 180 feet (27.43 to 54.86 meters). The 30-degree shots had a range of 170 to 305 feet (51.82 to 92.96 meters). The 40-degree shots had a range of 225 to 365 feet (68.58 to 111.25 meters), and the 45-degree shots had a range of 250 to 275 feet (76.20 to 83.82 meters), with one wildcat shot soaring more than 450 feet (137.16 meters).

Fusees wobble when shot and often land on end, breaking or extinguishing the flame. Ricocheting and bouncing are common, resulting in very low placement accuracy. Fusees are generally suitable for fine fuels and some moderate fuels.

Slingshot Launcher

A hunting slingshot can launch plastic spheres filled with potassium permanganate injected with ethylene glycol (antifreeze) (Figures 16 and 17).

Slingshots are commonly available at hunting supply stores for \$9 to \$12. Plastic syringes are commonly available from veterinarian suppliers for 80 cents for a disposable, single-dose unit to about \$10.20 for a reusable, adjustable model. Needles (16-gauge) are about 25 cents each. Spheres filled with potassium permanganate must be ordered, and cost about 15 cents each. Ethylene glycol (antifreeze), a common product, generally costs less than \$5 per gallon (3.79 liters).

The ethylene glycol produces a chemical reaction resulting in a 6-inch (152 mm) flame that generally lasts 2 to 3 minutes, with an outside range of 1 to 6 minutes (Figure 18). The flaming spheres produce plastic fumes and leave a gooey residue if the ensuing fire does not incinerate them.

Because of the fire danger in 1994, the spheres were loaded with 1 cc of water (instead of antifreeze) for distance testing. The spheres were launched at approximate angles of 15, 30, and 40 degrees. The low angle (15 degrees) resulted in a range of 140 to 157 feet (42.67 to 50.29 meters), the medium angle a range of 140 to 165 feet (42.67 to 47.85 meters). The high angle resulted in the widest range of distance, 150 to 170 feet (45.72 to 51.82 meters). Distance



Figure 16.—Injecting the plastic sphere with potassium permanganate.



Figure 18.—A burning sphere.



Figure 17.—Launching the sphere.

varies depending on how far back the slingshot is drawn. All shots resulted in numerous bounces and rolls. Placement accuracy was quite low.

It takes a minimum of two people to launch the spheres. One person injects the ethylene glycol into the sphere and hands it to the launcher, who fits it into the sling, aims, and fires it. The objective is to have the sphere land on the ground before it begins to flame (about 30 seconds).

This system is suitable for fine to some moderate fuels. The manufacturer also notes that the spheres will float on water while burning.

In testing, a number of the spheres did not ignite. According to the factory representative, this is the result of overpriming, which can be alleviated by diluting the ethylene glycol with 10 percent water or by using a cheap brand of antifreeze.

Safety is a major factor with this system. Users could inject themselves with ethylene glycol, or hold the injected sphere too long and get burned. Spheres are often difficult to detect when they land in heavy slash. Avoid skin contact with the potassium permanganate in the spheres, as it burns on contact. Personnel should be thoroughly familiar with the ignition properties of this system and practice in advance.





Discussion

A wide variety of ignition devices are available for starting backfires in both prescribed fire and wildfire situations. These range from devices that are classified as flammable solids, oxidizers, flammable liquids and gases, and explosives 1.4 G (fireworks classification). The designation of each device is typically displayed on the shipping container. Appropriate laws for transportation, handling, and storage apply.

To transport by air, obtain a copy of the *Aviation Transport of Hazardous Material Guide* from the National Interagency Fire Center in Boise, ID.

Transportation of hazardous materials by ground vehicle is controlled by the Department of Transportation. Appropriate laws are provided in the *Code of Federal Regulations 49 CFR*. These are subject to interpretation from State to State. Therefore, it is important to check with local authorities if there is a question. Most States allow for the transportation of “consumer” quantities without any restrictions. However, as users of hazardous materials, Forest Service employees must be knowledgeable of the materials they are using and transporting. They must have both a job hazard analysis and a materials safety data sheet on hand.

A “consumer” quantity typically has been purchased from a local hardware store or retailer for the purpose of being consumed by the buyer. “Commercial” quantities generally require more information, especially on the packaging. Quantities over 1000 pounds or 110 gallons require placarding and a commercial driver’s license. Additional information can be obtained from *Ground Ignition Systems: An Equipment Guide for Prescribed and Wildfire* MTDC publication 9351-2806, or your Forest or unit hazardous materials coordinator.

Training

To date there are no formal safety training or certification programs available for using most of the ground ignition systems. However, in wildland suppression situations, follow the guidance in Forest Service Manual 5126 to meet minimum standards. In prescribed fire situations, refer to guidance in Forest Service Manual 5143 to meet minimum standards. Personnel should review the information contained in these reports and conduct appropriate safety sessions to become acquainted with each device before its use. Use of some explosive materials (Burnol, Cap-and-Fuse) may require a blaster’s certification.

Personal Protective Equipment (PPE)

All personnel on fire suppression and prescribed fire assignments must as a minimum, wear fire-resistant pants, fire-resistant shirt with sleeves rolled down, hard hat, eye protection, gloves, and 8-inch lace-up leather boots with nonskid soles. The personal protective equipment must comply with NFPA 1977, *Protective Clothing and Equipment for Wildland Fire Fighting 1993 Edition*. A fire shelter is required for fire suppression. Additional protective equipment may be necessary based on the project or ignition device used (see *Health and Safety Code Handbook* FSH 6709.11). Examples are dust respirators, rubber gloves, and aprons for mixing gelled fuels, or hearing protection when using noisy equipment.





Conclusions

Solid ignition devices can generally be used in fine, dry fuels. In wetter conditions, materials may need to be coated with semisolid fuels such as a thickened gasoline or diesel mixture or with a liquid dispensed from the hand-held drip torch or a flame thrower.

Practical knowledge of the firing equipment is essential to accomplish the job efficiently and safely. Devices that work well to start backfires in nearby fine, dry fuels may not be effective in distant wet areas or in heavy slash. During a volatile fire season, such as the summer of 1994, all the devices listed would be effective under a variety of conditions.

Combining methods can increase effectiveness while reducing safety risks. Using a torch to ignite a line of fusees placed in fine fuels can create a line of fire similar to that caused by repeated applications of a drip torch.

Where there is safe access, fusees can be used to ignite gelled gasoline packets placed in heavier fuels. In less accessible areas, reasonably accurate launchers, such as the 25 mm signal pistol, might be used to ignite gelled gasoline packets placed beforehand, increasing the incendiary potential of the pistol.

Field personnel will have to evaluate the potential effectiveness of the individual type of equipment versus the safety hazards, types of fuels to be burned, terrain, weather conditions, personnel, equipment available, and other factors. No matter which devices are employed, the operator should be thoroughly familiar with their operation, characteristics, and hazards.





Product Source List

(Note: Many companies have minimum orders or require substantial lead time.)

Solid Fuel Firestarters:

Wax and Wood Fire Nuggets,
250 nuggets for \$35.50

Fire Sticks,
bag of 12 for 72 cents

Petroleum-Based Gel Fire Ribbon,
3.75-ounce tube for under \$4 retail

Petroleum Packet Lite-A-Log,
case of 72 for \$10.38

Source:

Lightning Nuggets, Inc.
Phone: 800-468-4487

Coghlan's of Winnipeg, Canada
Phone: (240) 284-9550

Mautz Paint Company
Phone: (608) 255-1661

Morgro Chemical Company
Phone: 800-221-1049

Fusees:

#10105, 12 for \$4.59

GSA

Plastic Bag Sealer:

Audion's Seal Master Model 230-SA,
\$635 plus shipping

Birnberg Machinery, Inc.
Phone: (708) 673-5243

Plastic Bag:

(3 mil): 6.5-feet x 9-inch bags,
1,000 bags for approximately
\$110 plus shipping.

Fisher Container Corporation
Phone: (708) 866-6050

Outward Burning Fuse:

Ignita-cord, or Thermalite, medium speed.
This product will be produced in Mexico
in 1995. Call for prices.

Formerly manufactured by ICI of Canada (Texas office)
Phone: (214) 387-2400

Gelled Fuel Thickener:

Fire-Gel, #GS07F5193,
50 to 500 pounds for 60 cents per pound,
(quantity price break available).

GSA

M-4 (first generation military thickener),
#0962, 100-pound drum for \$8.

GSA

Sure-Fire (formerly Sure-Fire II),
50 pounds for \$4.95 (price break available).

Simplex
Phone: (503) 257-3511

Bore Sealing Caps:

#30 tapered cap/plug,
1,000 caps for \$31.88 plus shipping.

Alliance Plastics
Phone: (814) 899-7671

Flare Pen:

- Military cartridges, #1370-00921-6118;
- Launcher kits (pen and seven flares), #1370-00921-6172;

- Cartridges, #1370-01-216-3243 L258;
- Launcher kits, #1370-01-230-2974 L118, and #1370-01-123-4745 MK 31 Model 0.

All cartridges are \$1.70 for a strip of seven, packed 1,400 per container. Kits are \$11.44 each, packed either 102 or 204 per container.

Commercial Skyblazer.
Three self-launching cartridges for \$12.39.

These are subject to an additional hazardous materials shipping charge. They cannot be shipped to California by private parcel delivery companies.

Source:

U.S. Army Armament Munitions and Chemical Command
Phone: (309) 782-6504 or 782-6874

U.S. Navy Chief of Naval Operations
Phone: (301) 743-6043, ext. 192

Skyblazer Signal Products, Inc.
Phone: (714) 254-8350

Signal Pistol and Cartridges:

12-gauge and 25-mm

Cartridges are subject to an additional hazardous materials shipping charge. They cannot be shipped to California by private parcel delivery companies.

(for nearest supplier), Standard Fusee
Phone: 800-851-5260, or (317) 472-4375

Flare Launcher and Cartridges:

- 37-mm rifle, #702-01, \$199;
- 37-mm pistol, #701-98, not available;
- Starburst reloads, #701-94, \$59.95 for 25;
- Super Nova cartridges #701-71SN, \$35 for 10.

Prices do not include shipping. Cartridges are subject to an additional hazardous materials shipping charge. They cannot be shipped to California by private parcel delivery companies.

MAC
Phone: 800-344-4622

Spheres with Potassium Permanganate:

Price per 1,000 is \$149 plus shipping.

Aerostat
Phone: (352) 787-1348