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Coordinating Group



# NWCG Standards for Ground Ignition Equipment

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The *NWCG Standards for Ground Ignition Equipment* establishes standards for ground ignition equipment and procedures for use in wildland and prescribed fire operations by federal, state, and local agencies. These standards:

- Ensure that all ground ignition operations are performed in a safe and efficient manner.
- Provide a framework within which areas, regions, states, and local units can provide their own supplemental, site-specific guidance.
- Provide the minimum standards and specifications for ground ignition equipment.
- Provide basic information for each type of commonly used ground ignition equipment to aid with safe operation and to help with selecting proper equipment for the desired ignition results.

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The National Wildfire Coordinating Group (NWCG) provides national leadership to enable interoperable wildland fire operations among federal, state, tribal, territorial, and local partners. NWCG operations standards are interagency by design; they are developed with the intent of universal adoption by the member agencies. However, the decision to adopt and utilize them is made independently by the individual member agencies and communicated through their respective directives systems.

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# Chapter 1—Introduction

## Guidelines for Contracted Ground Ignition Services

Private vendors own and operate ground ignition systems in some areas of the country. When an agency contracts for ground ignition personnel or equipment, the following guidelines shall be observed:

The requesting agency unit must ensure that the contractor uses qualified personnel and equipment that meet minimum requirements. This will be accomplished through contract requirements. The line officer will ensure that contracted ground ignition services are conducted in accordance with the procurement document. The requesting agency unit will provide information, including the location of the burn and the burn objectives, to help the contractor plan for the equipment, personnel, and supplies. This information will include the approximate acreage to be burned (overall acreage and acres per day), times and dates of the proposed burn, location and directions to the burn area, time and location of equipment inspection, supplies and equipment to be provided by the agency, agency contact names and phone numbers, and local support sources (bulk fuel providers, motels, etc.) and their phone numbers.

The contractor shall have a written operating plan specifying the equipment that will be used, the duties and responsibilities for the contractor's personnel, and the procedures for mixing fuel and for operations. The standard operating procedures, a copy of the qualifications of the contractor's employees, and training documentation shall be available for review when the Government representative arrives at the jobsite—before the start of contract work.

The contractor's equipment shall meet the minimum requirements listed in the resources section in each applicable chapter of this guide.

Any residual waste product, such as gelled fuel or drip torch fuel, shall be disposed of at an approved hazardous waste disposal site or, with the Government representative's approval, by incineration within the burn area.

Any deviation from established standard operating procedures or policy requires authorization by the contracting officer's technical representative (COTR) or designee.

## **Organization of This Document**

This document is divided into chapters. Each chapter covers a specific type of ground ignition system, including an equipment description, operational advantages and disadvantages, sources of equipment, situations favorable for use, safety requirements, qualifications, equipment inspections and fuel mixing methods, operating (normal and emergency) procedures, maintenance and storage, and resources.

A list of the minimum requirements for each type of equipment will be found in the corresponding chapter of this guide.

Equipment may be required to meet additional agency-specific standards.

## Chapter 2—ATV/UTV Torches

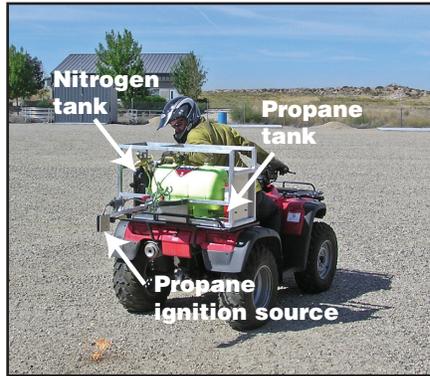
### Equipment Description

The all-terrain vehicle/utility-terrain vehicle (ATV/UTV) torch is a ground ignition device designed for mounting on the rear cargo platform of an ATV/UTV. It has a fuel tank, a system to dispense fuel, and an ignition source. The tank may be fabricated from carbon steel, stainless steel, or aluminum. Fuel may be dispensed by gravity, electric pump, or pressurized gas. The ignition source may be a lighted wick, propane torch, or electric spark (figures 2–1 through 2–3).

**Figure 2–1—A UTV torch with a lighted wick ignition source. This UTV has a water tank and pump for fire suppression.**



**Figure 2–2—An ATV torch with a propane ignition source. The torch on this ATV uses pressurized nitrogen gas to dispense fuel from the tank.**



**Figure 2–3—A UTV torch with an electrical spark ignition source.**



### ADVANTAGES AND DISADVANTAGES

#### Using ATV/UTV Torches

Advantages	Disadvantages
Greatly increase safety by reducing firefighter exposure and the number of people required for burning	Increase risk of vehicle rollover
Reduce the number of employees exposed to fireline hazards, such as tripping, stump holes, bee stings, and so forth	May create fire near the ignition vehicle that could burn the vehicle or entrap the operator if the ATV/UTV quits or becomes stuck
Reduce employee fatigue by decreasing the amount of walking, compared to hand lighting	Can make communication difficult because of the noise of the ATV/UTV
Develop a convective column more quickly, increasing control over the fire and reducing smoke management issues	Require additional PPE, training, and certification
More acres may be burned in less time than with hand lighting	Can distract the ATV/UTV operator from driving while the operator is using the torch
Provide a rapid escape platform	
Can be operated at different speeds	

## Sources of Equipment That Meet Standards

ATV/UTV torches must conform to the requirements in the “[Equipment Standards for ATV/UTV Torches](#)” section at the end of this chapter.

Hayes Manufacturing Co., Inc.  
106 Pelican Dr.  
P.O. Box 3309  
Pineville, LA 71361-3309  
Phone: 318-487-0100

Bill’s Machine  
5687 Beale Ford Rd.  
Pace, FL 32571  
Phone: 850-994-9820

Forestry Suppliers, Inc.  
205 West Rankin St.  
P.O. Box 8397  
Jackson, MS 39284-8397  
Phone: 800-647-5368

For copies of designs that meet specifications, contact:

Fire Equipment Specialist  
U.S. Department of the Interior  
Bureau of Land Management  
National Fire Equipment Program  
3833 South Development Ave.  
Boise, ID 83705  
Phone: 208-387-5445

Ignition Specialist  
Forest Service-NTDP  
5785 Highway 10 West  
Missoula, MT 59808-9361  
Phone: 406-329-3900

### ATV-use Restrictions

Use of ATV-mounted torches may be prohibited or restricted by some agencies. Refer to your agency ATV-use policy for more information.

## Situations Favorable for ATV/UTV Torch Use

An ATV/UTV torch may work well when:

- The terrain is safe for operating an ATV/UTV
- Sites have open timber stands or grasslands
- Burn units are large
- Areas need to be ignited quickly
- Protecting point sources of remote resources

## Safety Requirements

Hazard analysis information for ATV/UTV torch operations, including use of ATVs/UTVs and flammable liquids, is provided in the “[ATV/UTV Torch Resources](#)” section at the end of this chapter. Prepare and review your hazard analysis document before beginning work.

### Required Personal Protective Equipment (PPE)

- Head protection following agency policy
- Flame-resistant pants
- Flame-resistant shirt
- Leather gloves
- Approved boots
- Eye protection
- Hearing protection (where vehicle design, head protection design, speed, or equipment in use exceeds occupational noise exposure limits)
- Fire shelter

### Required ATV/UTV Equipment

- Fire extinguisher
  - Mount the fire extinguisher so it is easily accessible; recommended minimum rating is 10-B:C
  - Do not mount the fire extinguisher on the torch
- Handtool, such as a combi or shovel
- Handheld radio (minimum method of communication)

### Recommended Additional ATV/UTV Equipment

- Winch
- Water tank or bladder bag
- Skid plates (figure 2–4)
- Brush guards
- Floor plates
- Puncture-resistant tires/Fix-A-Flat tire inflator
- Occupant side retentive devices, such as rigid half doors or netting

**Figure 2–4—A UTV with brush guards, skid plate, and puncture-resistant tires. Fire extinguishers are mounted within the torch operator’s reach.**



## **Transporting ATV/UTV Torch Fuel**

- Use approved containers—safety cans, jerricans, and fuel tanks that meet U.S. Department of Transportation (DOT) specifications.
- Avoid transporting fuel on public highways in containers that do not meet DOT specifications.
- Ensure that all fuel containers are properly secured during transportation.
- Avoid transporting more than 440 pounds of hazardous materials, including torch fuel, in one vehicle—all containers must be smaller than 8 gallons.
- If you are transporting more than 440 pounds of torch fuel (or other hazardous materials) or if any fuel container is larger than 8 gallons, DOT hazardous materials training is required. In addition, you must carry shipping papers and a copy of the *Emergency Response Guidebook* in the vehicle.
- If you are transporting 1,001 pounds or more of torch fuel or if any container is larger than 119 gallons, the driver must have a commercial driver's license (CDL) and DOT hazardous materials training. In addition, the vehicle must be placarded. You must carry shipping papers and a copy of the *Emergency Response Guidebook* in the vehicle.

For more information on transporting fuel, refer to the *NWCG Standards for Transporting Fuel*.

## **Qualifications**

To be qualified to use ATV/UTV torches for incident or project work, individuals must meet prerequisites and training requirements.

### **Prerequisites**

For operators:

- Hold the position of Type 2 firefighter (FFT2) or prescribed fire crewmember (RXCM).
- Hold ATV/UTV operator certification following agency requirements.

For instructors:

- Hold the position of single resource boss.
- Hold ATV/UTV operator certification following agency requirements.
- Demonstrate proficiency with an ATV/UTV torch.

### **Minimum Training**

For operators:

- Read and understand the information in this chapter.
- Read the ATV/UTV torch manufacturer's operating instructions.
- Receive operational training from an instructor.
- Receive agency-specific ATV/UTV torch training.
- Receive other training that supports development of knowledge and skills, including S-290 (*Intermediate Wildland Fire Behavior*) and S-219 (*Firing Operations*).

For instructors:

- Demonstrate proficiency with an ATV/UTV torch.

## Position Responsibilities

For torch operators:

- Prepare, install, operate, maintain, and clean the torch and ATV/UTV.
- Coordinate ignition actions closely with other fire personnel.
- Coordinate with the burn supervisor to verify that desired ignition tactics are implemented and are effective. Adjust ignition patterns as required.
- Recognize malfunctions and act accordingly.
- Make sure the torch is correctly installed, the vehicle's weight limit is not exceeded, and the vehicle remains properly balanced.

## Inspecting ATV/UTV Torches and Mixing Fuel

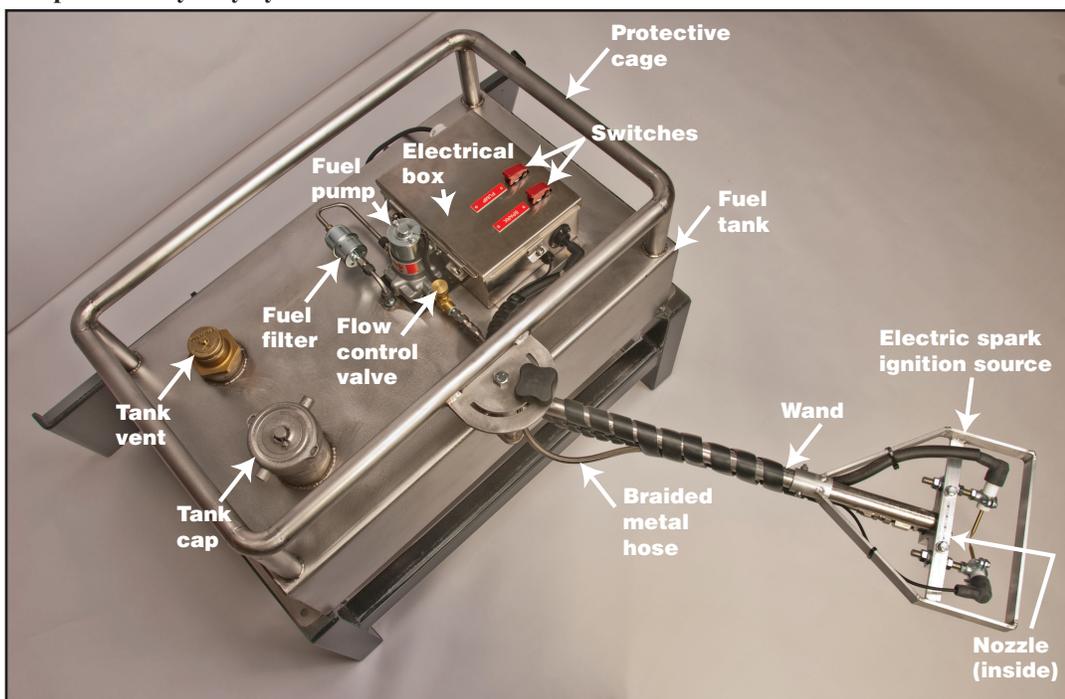
Before torches are used, the equipment must be inspected and readied for the field.

### Torch Inspections

Inspect the following (figures 2–5 through 2–9):

- Valves for leaks and damage.
- Filters for damage from dirt and debris.
- Hose and fitting connections for leaks.
- Fuel lines for cracking, cuts, leaks, and other damage.
- Switches for damage.
- Straps, buckles, or other fasteners, ensuring the torch is secured to the ATV/UTV.
- Fuel tank for leaks.
- Pump for leaks, clogs, or damage (see figure 2–6).
- Nozzle for damage, clogs, or missing parts.
- Igniter system for shorts or wiring damage.

Figure 2–5—An example of ATV/UTV torch parts that must be inspected before use. Specific components may vary by model.





- Tank cap for cross threading or damaged seals (see figure 2-7).
- Tank vent for damage (see figure 2-8).
- Wick snuffer (if equipped) for breakage.
- Electrical fuses for proper size.
- Pump wiring and connections (if equipped) for damage.
- The quick release mechanism on the torch's base plate, making sure that it is installed properly and is not damaged (see figure 2-9).

Replace or repair any damaged parts of the torch before using it.

**Figure 2-6**—Inspect the fuel pump for obvious damage and listen for correct operation.



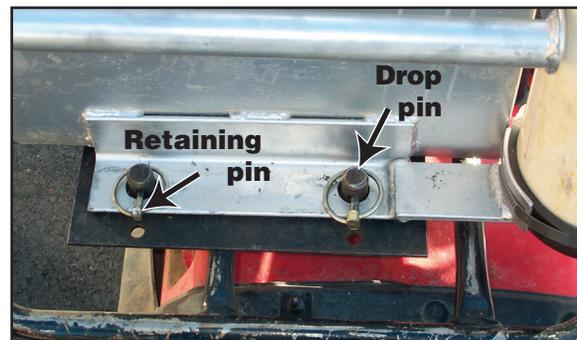
**Figure 2-7**—A fusible cap for a fuel tank. If the tank catches fire, the cap will melt to prevent excessive pressure from building. Inspect the cap for cross-threading or damaged seals.



**Figure 2-8**—This two-way tank vent prevents pressure or a vacuum from building up inside the tank. The vent has a flame arrester. Inspect the vent for external damage. Remove the vent to check for internal damage and clogging.



**Figure 2-9**—Many torches have a pinned quick release mechanism. Pull the retaining pin to allow the drop pin to fall, releasing the torch from the ATV/UTV.



## **ATV/UTV Inspections**

Inspect the ATV/UTV following agency policy. Before using the ATV/UTV, make sure that it is free of all combustible debris, such as needles, leaves, and grass.

## **Mixing ATV/UTV Torch Fuel**

When mixing fuel:

- Wear proper PPE.
- Use only approved containers (safety cans, jerricans, and fuel tanks that meet DOT specifications).
- Label the fuel containers properly.
- Select the proper fuel mixture ratio for the job. Refer to your agency's policy for authorized fuel mixtures. Mixtures other than those authorized by the agency require an additional job hazard analysis (JHA) before use.
- Bond the fuel containers while filling them to prevent static electricity from building up. Keeping the fuel nozzle in contact with the container provides electrical bonding.
- Do not fill fuel containers or mix fuel in the bed of a vehicle.
- Mix fuel only in well-ventilated areas.
- Mix the fuel thoroughly before using it in an ATV/UTV torch.

## **Normal Operating Procedures for ATV/UTV Torches**

Rollovers are serious risks for ATV and UTV operators. Mounting a torch raises the vehicle's center of gravity and increases its overall weight, making the vehicle less responsive to the operator. Exposure to flammable liquids and their fumes are also hazards.

Follow these procedures when using ATV/UTV torches.

### **Preparing the Torch for Use**

- Properly install the torch on the rear cargo rack of the ATV/UTV following the manufacturer's recommendations (if available).
- Verify that the weight of the torch and other accessories do not exceed the capacity of the ATV/UTV or make it unbalanced.
- Make sure the torch is securely fastened to the ATV/UTV.
- Connect electrical power to the torch, if applicable.

### **Transporting the ATV/UTV**

- Transport the ATV/UTV following agency requirements.

### **Transporting the Torch**

- Transport the empty torch to the staging area.
- Make sure that the wand is secured and not protruding beyond the edge of the vehicle that is carrying it. The wand may be removed while the torch is being transported.

## **Fueling or Refueling the Torch**

- Turn off the ATV/UTV and allow the vehicle to cool. Otherwise, the vehicle's hot exhaust system could ignite the torch prematurely.
- Close all torch valves.
- Ensure that the wick is completely extinguished and cooled.
- Do not allow smoking, open flame, or a heat source within 50 feet of the torch.
- Do not completely fill the torch fuel tank. Instead, fill the tank to about 90 percent of capacity and replace the tank cap.
- Wipe up any fuel that might have spilled on the tank or the ATV/UTV.
- Complete inspections.

## **Using the Torch**

To operate the torch, consult the manufacturer's instructions; some models have an instruction placard and labels showing each of the torch's valves.

- Open all valves.
- Adjust the valves for the desired flow of fuel.
- Light the wick or initiate the ignition system when ready to begin active burning.
- Operate the ATV/UTV safely. Make adjustments to the torch valves as necessary.
- If the operator is not familiar with the area being burned, the operator should scout the area before firing.
- In thick fuels, the operator should ride into an area and fire only on the way out.
- In hazardous situations, such as when burning thick fuels or swampy savannas, two ATVs/UTVs should be used together; one to do the firing and the other to serve as a lookout.
- Be aware of burning fuel that may continue dripping from the torch after stopping the ATV/UTV.

## **Emergency Operating Procedures for ATV/UTV Torches**

ATV/UTV operators need to know what to do in the following situations:

- Stuck, stalled, or rolled ATV/UTV
  - Stop igniting vegetation.
  - Extinguish the wick.
  - Extinguish any fires near the machine using the water tank or a handtool.
  - Notify others of your situation.
  - Request help.
- Torch catches fire
  - Stop ignition:
    1. If practical, try to extinguish the burning torch.
    2. If it is not practical to extinguish the torch, jettison the torch and drive away.
    3. If you cannot extinguish or jettison the torch, abandon the burning ATV/UTV and torch. Move a safe distance away.
    4. Notify others of your situation.
    5. Request help.

### Caution

If the torch catches fire, do not jeopardize your safety to save the torch or the vehicle!

## TROUBLESHOOTING

### Torch Does Not Dispense Fuel

Make sure the electrical system is connected.

Check for a broken wire or blown fuse.

Check the pump for defects.

Make sure the tank vent is not plugged.

Check for obstructions in hoses, piping, or tubing.

Check the nitrogen pressure (for pressurized systems)—the pressure may be too low.

### Torch is Difficult to Keep Ignited

Make sure the wick, propane torch, and igniter electrodes are adjusted properly.

Make sure the propane bottle is not empty (propane ignition systems only).

Check the vibrator or coil for problems (electronic ignition systems only).

Check the fuel mixture—it may have too much diesel.

### Fuel Burns Up Before Reaching Vegetation

Check the fuel mixture—it may have too much gasoline.

## Maintenance and Storage

Follow these procedures to make sure that ATV/UTV torches will be ready for their next use.

### Cleaning and Repair

- Following an inspection checklist, repair or replace damaged or broken equipment. Equipment that cannot be readily repaired should have a tag attached that identifies the problem.
- Remove any residual fuel from the tank. Store or dispose of residual fuel following agency policy.
- Close valves and remove lines from the pressure tanks of pressurized systems.
- To minimize the risk of mechanical failure when firing, have a certified ATV/UTV mechanic inspect the ATVs/UTVs used for torch operations every 6 months (or more frequently if the ATV/UTV is used heavily).

### Storing the Torch

- Store the torch in a secured facility out of the weather.
- Do not stack anything on top of the torch.

### Storing ATV/UTV Torch Fuel

- Store torch fuel following agency policy.
- For further guidance on fuel storage, consult your agency policy, your local hazardous materials coordinator, and the *Everyday HazMat User's Training Guide*.

## **ATV/UTV Torch Resources**

This section includes the following resources:

- Information for inclusion in a hazard analysis
- List of required safety data sheets
- Recommended spare parts
- Equipment standards for ATV/UTV torches
- Contract equipment inspection checklist
- ATV/UTV torch references

## Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

Information for ATV/UTV Torch Hazard Analyses		
Task	Hazards	Abatement Actions
Fueling and servicing ATVs/UTVs	Burns from hot engine	Turn off the engine. Allow it to cool before servicing or refueling.
Traveling	Cuts and bruises from brush and limbs	Wear standard Nomex clothing and PPE during firing. Maintain all brush guards in working condition. Wear eye protection.
	Head injury from a fall or collision	Wear head protection following agency policy for ATV/UTV use.
	Collision or falling from ATVs/UTVs	Make sure all operators are trained and experienced. Provide an ATV/UTV Safety Institute standard rider course for all new riders. Maintain safe speeds. Use only low gears when operating ATVs/UTVs off established roads and trails.
	High noise levels	Provide hearing protection.
	Overturning	Follow manufacturers' recommendations for sidehill operations. If more than 40 pounds is carried on the back of a four-wheel ATV/UTV, a counterweight must be carried on the front cargo rack. The counterweight must be securely strapped down or permanently mounted.
	Speed	Limit cross-country speed to 5 mph.
	ATV/UTV knocked into gear when dismounting	Apply the parking brake and turn off the ATV/UTV engine before dismounting.
Firing Operations	Vehicle and operator exposed to fire during operations	Mount a fire extinguisher (minimum rating of 10–B:C) on each ATV/UTV. The fire extinguisher shall be readily accessible and not mounted to the torch. If required by unit policy, ATVs/UTVs used for firing must have at least a 5-gallon water tank with an electric pump mounted on the vehicle. The preferred location is the front cargo rack. Scout the area before firing. Identify escape routes and safety zones. Use two ATVs/UTVs together; one to do the firing and the other to serve as a lookout. Carry a handtool, such as a combi or shovel, on all ATVs/UTVs used for firing. PPE must be worn during firing.
	ATV/UTV stuck in the burn area	Contact your supervisor immediately on the radio. Shut off torch fuel and extinguish the torch. Identify which of your escape routes and safety zones is closest. Time permitting, try to free the ATV/UTV. Clear vegetation around the ATV/UTV if time permits. Use the water tank to put out fire near the ATV/UTV, if possible. Do not jeopardize your safety to save the torch or the ATV/UTV.
Transporting the ATV/UTV	Damage to the ATV/UTV	Transport ATVs/UTVs following agency policy.

## List of Required Safety Data Sheets

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for ATV/UTV torches include:

- Diesel
- Gasoline
- Nitrogen (BLM torch)
- Propane

## Recommended Spare Parts

- Fuel pump
- Fuel filters
- Fuel line assemblies
- Fuses
- Electrical tape
- Extra wiring
- Extra wicks
- Extra wand
- Fuel caps
- Pressure relief valve (if equipped)
- Spare gas cylinders (pressurized torches only)

## Equipment Standards for ATV/UTV Torches

All components must be compatible with diesel and gasoline.

The torch shall be equipped with a quick release mechanism to allow the torch to be quickly removed from the ATV/UTV in an emergency ([see figure 2–9](#)).

### FUEL TANK

- The fuel tank must be made of metal.
- For ATVs, the fuel tank capacity shall not be more than 10 gallons, unless approved by a line officer.
- The fuel tank must be vented to prevent pressure from building up and to allow the fuel pump to operate properly.

### HOSES

- Must be compatible with gasoline and must have a braided metal cover.
- Must use swaged end fittings.

### FUEL PUMP

- The fuel pump and piping must be protected from damage in the event of a rollover.
- The fuel pump must be designed for use with gasoline and diesel.
- If the fuel pump or wand is gravity fed, a manually operated shutoff valve must be installed on the tank or the fuel line and the valve must be protected so it cannot be torn loose during operation. Pumps that draw fuel from the top of the tank do not require a tank shutoff valve.

## ELECTRICAL SYSTEM

- Wiring must be free of splices.
- An inline fuse must be installed as close to the ATV/UTV battery as possible.
- The minimum fuse size should be determined by multiplying the total electrical load required by all of the torch's electrical equipment by 1.5.
- All wiring shall be installed in an abrasion-resistant covering for protection.
- All electrical connections shall be sealed with silicone sealant or shrink tubing to prevent sparking, except for the quick disconnect used to allow the torch to be removed from the ATV/UTV.
- Solenoids (if used) must be explosion-proof.
- The torch's electrical controls shall be located up front within easy sight and reach of the operator.

## ATV/UTV

- Requirements
  - Cargo capacity adequate to carry the torch, water/foam unit, and other equipment (refer to the manufacturer's specifications)
  - Rack capacity adequate (refer to the manufacturer's specifications)
  - Liquid engine cooling system or auxiliary fan if engine is air cooled
  - Roll protection on UTV
  - Seat belts on UTV
- Recommendations
  - All-wheel drive
  - Engine size: 300 cubic centimeters or larger
  - Heavy-duty or puncture-resistant tires
  - Skid plates
  - Brush guards
  - Running boards

## Contract Equipment Inspection Checklist

- The fuel tank is metal.
- For ATV only: the maximum tank capacity is 10 gallons, unless approved by a line officer.
- The fuel tank is vented to prevent pressure buildup and to allow the fuel pump to operate properly.
- The fuel pump and piping are protected from rollover damage.
- If the fuel pump or wand is gravity fed, a manually operated shutoff valve is installed on the tank or the fuel line and the valve is adequately guarded so it cannot be torn loose during operation. Pumps that obtain suction from the top of the tank do not require a tank shutoff valve.
- All components are compatible with diesel and gasoline.
- All hoses have a braided metal cover and swaged end fittings.
- The wiring is free of splices.
- An inline fuse is installed as close to the ATV/UTV battery as possible.
- The fuse size is at least 1.5 times the total electrical load required by all the torch's equipment.
- All wiring has an abrasion-resistant cover for protection.



- ❑ All electrical connections, except the quick disconnect used to allow removal of the torch from the ATV/UTV, are sealed with silicone sealant or shrink tubing to prevent sparking.
- ❑ Solenoids (if used) must be explosion-proof.
- ❑ The torch's electrical controls are located within easy sight and reach of the operator.
- ❑ The torch is equipped with a quick-release mechanism for emergencies.

### **ATV/UTV Torch References**

See [appendix B](#) for additional ground ignition references.

*NWCG Standards for Transporting Fuel*, PMS 442, available at <http://www.nwcg.gov/publications/442>.

*Everyday HazMat User's Training Guide*, 0471–2810–MTDC, available at [https://www.fs.usda.gov/t-d/everyday\\_hazmat/](https://www.fs.usda.gov/t-d/everyday_hazmat/).



## Chapter 3—Drip Torches

### Equipment Description

A drip torch is a ground ignition device that has a fuel tank, a spout (also known as a burner), and an igniter with a wick. The drip torch tank is filled with a mixture of gasoline and diesel. The wick is ignited and drip torch fuel is poured out of the tank, through the spout, and past the burning wick. The burning wick ignites the drip torch fuel, which starts the fire (figure 3–1).

Figure 3–1—A firefighter using a drip torch.



The two most common types of drip torches—the standard drip torch and the Panama torch (figures 3–2 and 3–3)—will be discussed in this chapter. The standard drip torch, available from the Defense Logistics Agency (DLA), has an aluminum tank and a spout about 12 inches long that can be stored inside the tank for transport and storage. The Panama torch has a stainless steel tank and a spout that may be 12, 15, or 19 inches long (figure 3–4). The spout must be removed from a Panama torch before it can be transported with fuel.

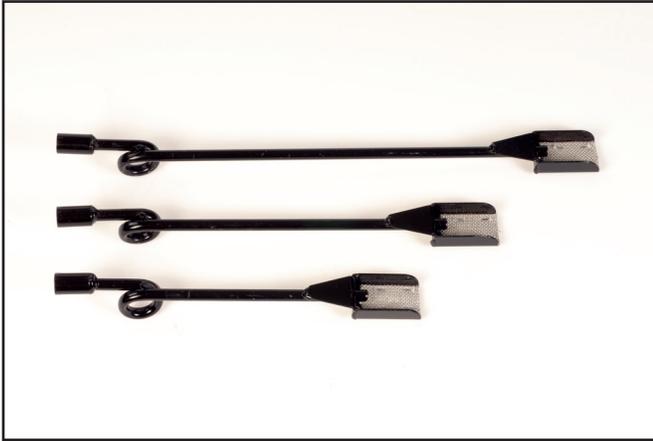
Figure 3–2—A Panama drip torch with a 19-inch spout installed and a standard drip torch, both configured for use.



Figure 3–3—A Panama drip torch and a standard drip torch, both configured for transport and storage.



**Figure 3-4—The spouts of Panama drip torches may be 12, 15, or 19 inches long.**



### **Sources of Equipment That Meet Specifications**

- New drip torches are available from DLA (NSN 4210-01-558-9951) and from the National Fire Equipment System (NFES 000241) catalog. Drip torches purchased elsewhere must meet Forest Service specification 5100-614 or 5100-616. These specifications are included in the [“Drip Torch Resources”](#) section at the end of this chapter.

### **Situations Favorable for Drip Torch Use**

A drip torch may work well when:

- Burning in areas with limited access
- Broadcast burning small areas
- Burning out along control lines

### **Safety Requirements**

Hazard analysis information for drip torch operations is provided in the [“Drip Torch Resources”](#) section at the end of this chapter. Prepare and review your hazard analysis document before beginning work.

#### **Required Personal Protective Equipment (PPE)**

- Hardhat
- Flame-resistant pants
- Flame-resistant shirt
- Leather gloves
- Approved boots
- Eye protection

#### **Recommended PPE**

- Over-the-calf, wool-blend socks
- Spare full water bottle or small fire extinguisher (in case fuel ignites on clothing)

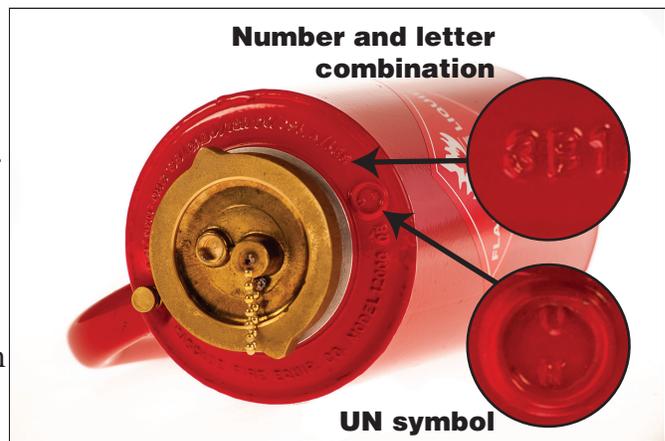
## ADVANTAGES AND DISADVANTAGES

Using Drip Torches	
Advantages	Disadvantages
Inexpensive, easy-to-use, portable	Exposes the operator to the flammable gasoline/diesel mixture
Suitable for terrain where other ground ignition equipment cannot be used	Require a larger crew working longer to complete a burn (increasing the exposure to hazards during burning) when compared to other forms of ground ignition
Requires little setup time	Can become tiring to carry
Effective in most fuel types	

### Transporting Drip Torch Fuel

- Use approved containers—safety cans, jerricans, drip torches, and fuel tanks that meet DOT specifications (figure 3–5).
- Avoid transporting fuel on public highways in drip torches that do not meet DOT specifications.
- Ensure that all fuel containers are properly secured during transportation.
- Avoid transporting more than 440 pounds of hazardous materials, including drip torch fuel, in one vehicle—all containers must be smaller than 8 gallons.

**Figure 3–5—Drip torches that meet DOT specifications will be marked with the UN symbol followed by a number and letter combination such as 1B1 or 3B1.**



If you are transporting more than 440 pounds of drip torch fuel, other hazardous materials, or if any fuel container is larger than 8 gallons, DOT hazardous materials training is required. In addition, you must carry shipping papers and a copy of the *Emergency Response Guidebook* in the vehicle.

If you are transporting 1,001 pounds or more of drip torch fuel or if any container is larger than 119 gallons, the driver must have a commercial driver’s license (CDL) with a hazardous materials endorsement in addition to DOT hazardous materials training. The vehicle must also display the appropriate placards.

For more information on transporting fuel, refer to the *NWCG Standards for Transporting Fuel*, PMS 442.

## Qualifications

To be qualified to use a drip torch for incident or project work, individuals must meet prerequisites and training requirements.

### Prerequisites

For operators:

- Hold the position of Type 2 firefighter (FFT2) or prescribed fire crewmember (RXCM).

For instructors:

- Hold the position of FFT2 or RXCM.
- Demonstrate proficiency with a drip torch.

### Minimum Training

For operators:

- Read and understand the information in this chapter.
- Read the drip torch manufacturer's operating instructions.
- Receive operational training from an instructor.

For instructors:

- Demonstrate proficiency with a drip torch.

## Inspecting Drip Torches and Mixing Fuel

Before drip torches are used, the equipment must be inspected and readied for the field.

### Inspections

Inspect the following:

- Tank and tank cover for damage and leaks.
- Handle for breakage.
- Tank cover seal for damage and leaks (figure 3–6).
- Breather valve and discharge plug O-ring for damage and leaks (figure 3–7).
- Breather valve tube for damage and proper installation (figure 3–8).
- Fuel spout and nozzle for damage.
- Lock ring for damage.
- Check valve and screen for damage or missing parts (figures 3–9 and 3–10).
- Wick assembly for proper installation and damage.

Repair or replace any damaged or missing parts before use. Do not use a drip torch that leaks. Do not interchange parts between drip torches that meet the DOT specification and those that do not.

Figure 3-6—Inspect the tank cover seal for damage.



Figure 3-7—Inspect the discharge plug O-ring for damage.

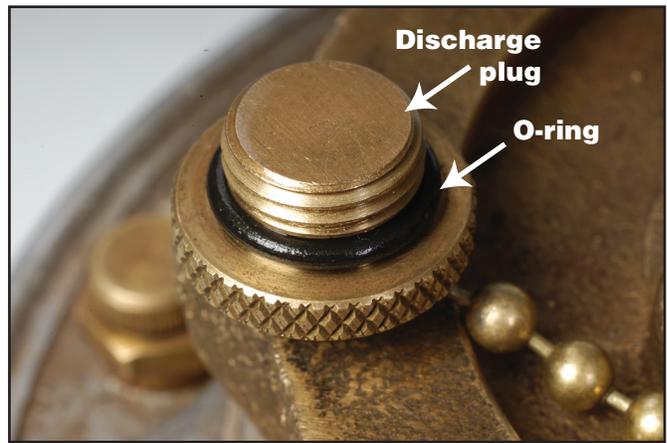


Figure 3-8—Remove the tank cover so you can look inside the tank to verify that the breather valve vent tube is installed and that it has not been damaged. If the vent tube is missing, fuel can pour out of the breather valve and catch fire when the torch is used.

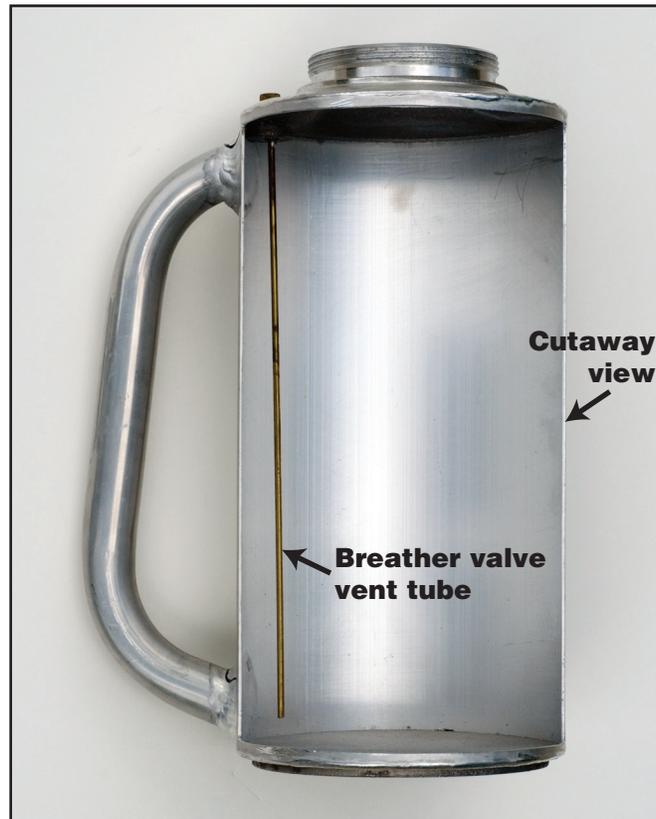


Figure 3–9 —Verify that the check valve is installed and undamaged.

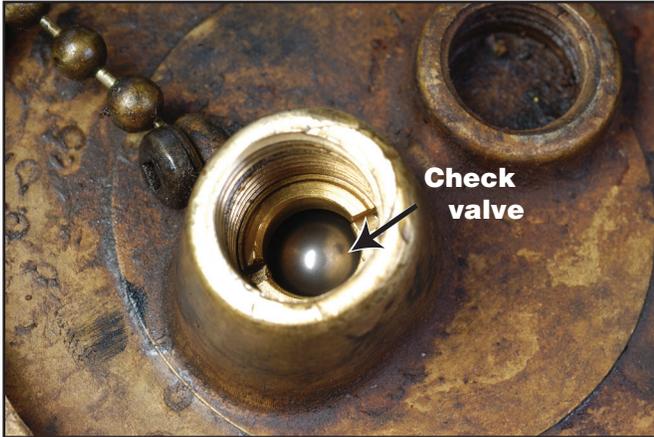
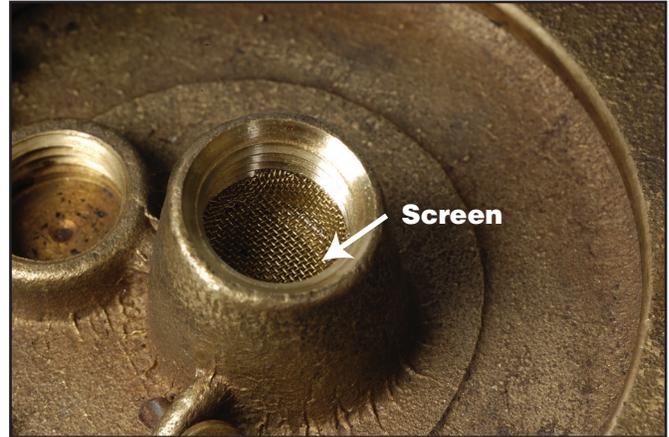


Figure 3–10—Make sure the check valve screen is installed and undamaged.



### Mixing Fuel

When mixing fuel:

- Wear proper PPE.
- Use only approved containers (safety cans, jerricans, and drip torches and fuel tanks that meet DOT specifications).
- Ensure that the fuel containers are properly labeled.
- Select the proper fuel mixture for the job. Refer to your agency’s policy for authorized fuel mixtures. Mixtures other than those authorized by the agency require an additional hazard analysis, such as a job hazard analysis, before use.
- Ensure fuel containers are properly bonded while they are being filled (keep the fuel nozzle in contact with the container, figure 3–11).
- Do not fill fuel containers or mix fuel in the bed of a vehicle. Drip torches should be placed in a spill containment barrier before filling.
- Mix fuel only in well-ventilated areas.
- Ensure that the fuel is thoroughly mixed before using it in a drip torch.

Figure 3–11—Make sure that the pump or fuel container nozzle contacts the tank when filling a drip torch. Contact ensures electrical bonding, preventing static electricity from building up.



## Normal Operating Procedures for Standard and Panama Drip Torches

Follow these procedures when using a standard or Panama drip torch.

### Standard Drip Torch

The operator must wear proper PPE.

#### PREPARING THE TORCH FOR USE

- Unscrew the lock ring from the fuel tank (figure 3–12).
- Remove the plug from the tank cover and screw it into the threaded plug holder (figure 3–13).
- Remove the tank cover from the tank (figure 3–14).
- If the fuel tank is empty, fill the tank with fuel. Leave at least 1 inch of the tank unfilled, so the fuel has room to expand. The torch should be filled on the ground at least 50 feet from any open flame. Clean spilled fuel from the outside of the tank.
- Install the tank cover with wick and fuel nozzle extended (figure 3–15).
- Install the lock ring on the fuel tank and hand tighten the lock ring to ensure that the tank does not leak; do not overtighten the lock ring (figure 3–16).
- Open the breather valve to allow fuel to flow (figure 3–17).

Figure 3–12—Remove the lock ring from the fuel tank.



Figure 3–13—Screw the discharge plug into the threaded plug holder.



Figure 3–14—Remove the tank cover from the tank.





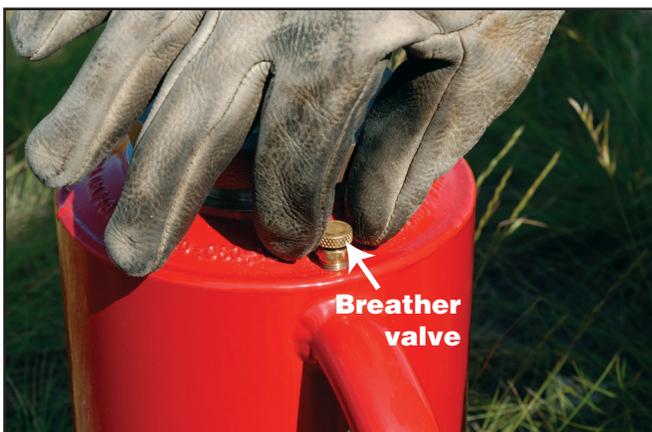
Figure 3–15—Install the tank cover with the spout ready for use.



Figure 3–16—Tighten the lock ring.



Figure 3–17—Open the breather valve.



#### IGNITING THE TORCH

- Hold the torch with the nozzle pointed down and allow a small amount of fuel to flow to the wick.
- Verify that fuel is not leaking from the tank cover seal.
- Tip the torch back so fuel stops flowing.
- Light the fuel on the wick with a match, lighter, another drip torch, or ground fire.

#### USING THE TORCH

- Carry the torch with the nozzle pointing up so fuel is not flowing from the nozzle when you are walking from one area that is being burned to another. If you are carrying a torch for long distances in areas that are not being burned, extinguish the wick.
- When igniting vegetation, make sure that the drip torch's nozzle and wick are not pointed at you or anyone else, as the torch can flare or spray fuel and cause injury. Tilt the nozzle down so the burning wick ignites the fuel stream.
- Adjust the opening of the breather valve as necessary to control the flow of fuel from the nozzle.
- Do not stand over the nozzle when setting the torch down. Fuel can spray and cause injury.

#### EXTINGUISHING THE WICK

- Allow the wick to burn out on its own. For your own safety, do not blow out the wick or use a glove to extinguish it.

## **REFUELING**

- Before refueling the torch, extinguish the wick and allow it to cool.
- Ensure that the drip torch is at least 50 feet away from any heat source before removing the lock ring and tank cover.
- Place the drip torch on the ground; do not refuel the torch in the back of a vehicle.
- Refuel the torch from an approved fuel container. When dispensing fuel into the torch, ensure that the fuel container's spout is touching the torch to prevent static electricity from building up.
- Wipe spilled fuel from the outside of the torch.
- Use a spill containment barrier when fueling drip torches.

## **PREPARING THE TORCH FOR TRANSPORTATION AND STORAGE**

- Make sure the wick is extinguished and has cooled.
- Remove the lock ring and tank cover.
- Invert the tank cover and install the cover so the fuel spout and wick assembly is stowed inside the fuel tank (figure 3–18).
- Install the lock ring and hand tighten.
- Unscrew the discharge plug from the plug holder and screw it into the fuel spout opening (figure 3–19). Hand tighten the plug to prevent the plug from leaking.
- Close the breather valve (figure 3–20) without overtightening, which can displace the O-ring and cause leaks.
- Secure drip torches to keep them from moving while they are being transported in a vehicle.

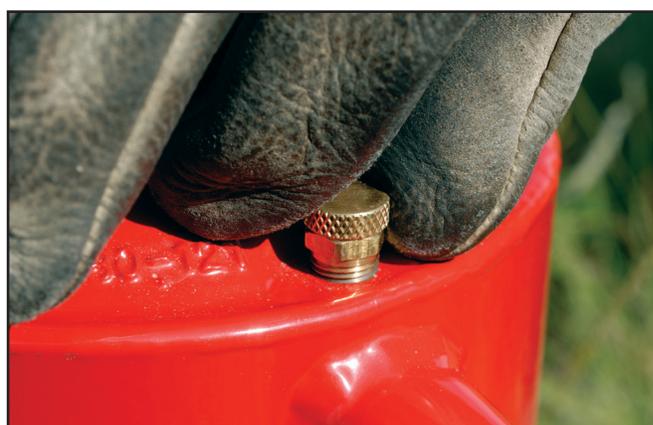
Figure 3-18—Install the tank cover with the fuel spout and wick assembly stowed inside the tank.



Figure 3-19—The discharge plug installed in the fuel spout opening.



Figure 3-20—The breather valve in the closed position.



## Panama Drip Torch

The operator must wear proper PPE.

### PREPARING THE TORCH FOR USE

- Install the discharge spout on the regulating valve (figure 3–21).
- If the fuel tank is empty, remove the filler cap from the tank and fill the tank with fuel. Leave at least 1 inch of the tank unfilled so the fuel has room to expand. The torch should be filled on the ground at least 50 feet from any heat source. Clean any spilled fuel from the outside of the tank.
- Hand tighten the filler cap to ensure that it does not leak. Do not overtighten.
- Open the vent valve (figure 3–22).
- Open the regulating valve to allow fuel to flow (figure 3–23).

Figure 3–21—Install the spout on the regulating valve of a Panama torch.

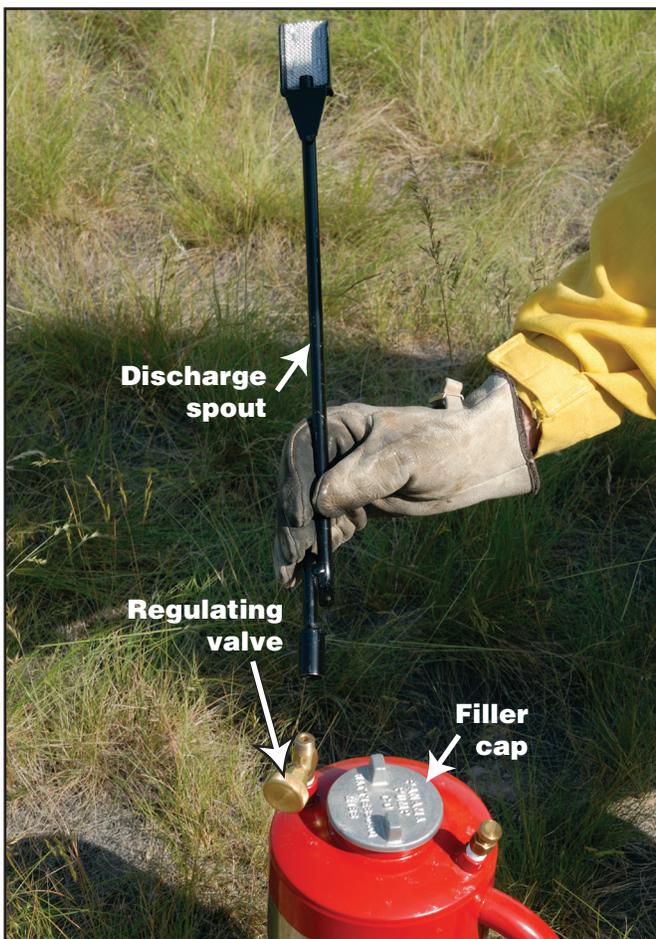


Figure 3–22—Open the vent valve of a Panama torch before use.



Figure 3–23—Adjust the regulating valve to control the flow of fuel.



### **IGNITING THE TORCH**

- Hold the torch with the burner pointed down and allow a small amount of fuel to flow to the wick.
- Verify that fuel is not leaking from the filler cap seal.
- Tip the torch back to stop the fuel from flowing.
- Light the fuel on the wick with a match, lighter, another drip torch, or ground fire.

### **USING THE TORCH**

- Carry the torch with the burner pointed up so fuel does not flow from the nozzle when you are walking from one area that is being burned to another. If you are carrying the torch for long distances in areas that are not being burned, extinguish the wick.
- When igniting vegetation, make sure that the nozzle or wick are not pointed at you or anyone else, as the torch can flare or spray fuel and cause injury. Tilt the burner down so the burning wick ignites the fuel stream.
- Adjust the opening of the regulating valve to control the flow of fuel from the nozzle.
- Do not stand over the nozzle when setting the torch down. Fuel can spray and cause injury.

### **EXTINGUISHING THE WICK**

- Allow the wick to burn out on its own. Do not blow the wick out or use a glove to extinguish the wick.

### **REFUELING**

- Before refueling the torch, let the wick burn out and allow it to cool. Ensure that the drip torch is at least 50 feet away from any heat source before removing the filler cap.
- Place the drip torch on the ground; do not refuel the torch in the back of a vehicle.
- Refuel the torch from an approved container. When dispensing fuel into the torch, ensure that the spout or nozzle of the fuel container is touching the torch to prevent static electricity from building up.
- Wipe spilled fuel from the outside of the torch.
- Use a spill containment barrier when fueling drip torches.

### **PREPARING THE TORCH FOR TRANSPORTATION AND STORAGE**

- Extinguish the wick and allow it to cool.
- Close the regulating and vent valves.
- Remove the discharge spout from the regulating valve.
- Ensure that the filler cap is tight and does not leak.
- Secure drip torches to keep them from moving when they are being transported.

## TROUBLESHOOTING

### Fuel Does Not Pour From Torch

Make sure that you have removed the discharge closure plug.

Check for an obstruction in the fuel spout.

Make sure that the breather valve is open and unobstructed.

### Torch is Difficult To Ignite

Make sure that the wick is saturated with fuel.

Check the wick. It may need replacing.

Check the fuel mixture—it may have too much diesel.

### Fuel Burns Up Before Reaching the Vegetation

Check the fuel mixture—it may have too much gasoline.

### Tank Cover Leaks

Make sure that the lock ring is tight.

Make sure that the cover seal is not missing, damaged, or defective.

## Emergency Operating Procedures for Standard and Panama Drip Torches

Drip-torch operators need to know what to do in the following situations:

- Clothing catches fire:
  - Replace fuel-soaked clothing as soon as possible.
  - If burning fuel is on clothing:
    - Extinguish with a water bottle or small fire extinguisher.
    - Drop pants.
    - Drop to knees and smother flames with gloved hands.
- Torch catches fire:
  - Toss the torch into the burn area, move a safe distance away, and let the torch burn itself out.
- Major fuel spill (more than 5 gallons):
  - Report the spill to your local environmental coordinator and follow your agency's procedures for containment and cleanup.

## Maintenance and Storage

Follow these procedures to make sure that drip torches will be ready for their next use.

### Cleaning and Repair

- Note any leakage
- Clean the drip torch as recommended by the manufacturer
- Tag damaged parts
- Replace any defective seals or other damaged parts

### Storing the Torch and Fuel

- Fuel should be stored only in drip torches that meet DOT specifications.
- All standard drip torches, whether full or empty, should be stored with the:
  - Fuel spout and wick assembly stowed inside the fuel tank (does not apply to the Panama torch)
  - Lock ring hand tightened
  - Closure plug installed and hand tightened (figure 3–24)
  - Breather valve closed

**Figure 3–24—A standard drip torch ready for transport or storage with the fuel spout stowed inside the tank, the lock ring tightened, the closure plug installed in the fuel spout opening and the breather valve closed.**



Drip torch fuel shall be stored in metal containers that meet OSHA requirements.

For further guidance on fuel storage, consult your agency policy, your local hazardous materials coordinator, and the *Everyday HazMat User's Training Guide*.

## Drip Torch Resources

This section includes the following resources:

- Information for inclusion in a hazard analysis
- List of required safety data sheets
- Recommended spare parts
- Equipment specifications for drip torches
- Contract equipment inspection checklist

## Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

Information for Drip Torch Hazard Analyses		
Task	Hazards	Abatement actions
Mixing fuel	Harmful vapors	Mix in well-ventilated area. Use an organic vapor respirator in confined or unventilated locations.
	Fire/burns	Keep ignition sources at least 50 feet away from the mixing area. Use no more gasoline than necessary in the fuel mixture.
	Eye and skin contact	Wear required PPE. Change flame-resistant clothing if fuel spills on clothing.
Filling the torch	Harmful vapors	Fill in well-ventilated area.
	Fire/burns	Keep ignition sources at least 50 feet away from the fueling area. Let the wick cool before removing the tank cover. Do not add fuel to the torch unless the torch is on the ground. Do not overfill the tank. Wipe any spilled fuel from the outside of the tank. Make sure the tank cover is tight.
	Eye and skin contact	Wear required PPE. Change flame-resistant clothing if fuel spills on clothing.
Using the torch	Leg/ankle injuries	Watch out for holes, limbs, and other tripping hazards while walking.
	Fire/burns	Ensure that the fuel is thoroughly mixed at the correct ratio to prevent flaring. A flaring torch is usually an indication that the fuel is not mixed properly. Keep the nozzle and wick pointed away from you and anyone else. Be alert in case the torch flares, which is an indication that the fuel is not mixed properly.

## List of Required Safety Data Sheets

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for drip torches include:

- Diesel
- Gasoline

## Recommended Spare Parts

- Fuel tank cover gaskets
- Closure plug O-rings
- Wick assemblies
- Lock rings
- Check valve assemblies
- Check valve screens
- Breather valve assemblies
- Closure plugs
- Closure plug chain assemblies
- Spout with fuel trap
- Tank cover
- Nozzle
- Clamps for wick
- Wick clamp screws



## Equipment Specifications for Drip Torches

Equipment specifications for drip torch 5100-614 and drip torch-extended burner 5100-616 are available at <<https://www.fs.usda.gov/t-d/programs/fire/specs.htm>>.

~~Contract Equipment Inspections Checklist~~ the standards established in this chapter.

### Drip Torch References

See [appendix B](#) for additional ground ignition references.

*NWCG Standards for Transporting Fuel*, PMS 442, available at <<http://www.nwcg.gov/publications/442>>.

*Everyday HazMat User's Training Guide*, 0471-2810-MTDC, available at <[https://www.fs.usda.gov/t-d/everyday\\_hazmat](https://www.fs.usda.gov/t-d/everyday_hazmat)>.

*Fire Equipment Storage and Refurbishing Standards*, PMS 448, available at <<http://www.nwcg.gov/publications/448>>.

*Specification 5100-614A, Drip Torch (Diesel and Gasoline Mixture)*, available at <<https://www.fs.usda.gov/t-d/programs/fire/specs.htm>>.

*Specification 5100-616, Drip Torch-Extended Burner (Diesel and Gasoline Mixture)*, available at <<https://www.fs.usda.gov/t-d/programs/fire/specs.htm>>.



## Chapter 4—Flares and Flare Launchers

### Equipment Description

Flares are used to ignite areas remotely that are not easily accessible on foot. When used with a flare launcher in a flare system, the point of ignition can be 300 feet away. One of the two basic types of flare systems uses a flare launcher that breaks open so a self-contained cartridge similar to a shotgun shell can be loaded (figure 4–1). The cartridge contains the flare and the powder to propel it. The flare launcher is typically cast aluminum or plastic. The flare launcher is opened and a cartridge is inserted into the launcher. The launcher is pointed toward the area to be burned and the operator pulls the trigger, igniting the powder and launching the flare. These flare launchers typically range in size from 12 gauge to 25 millimeters.

A second type of flare system (figure 4–2) uses a launcher with separate cartridges (also known as blanks or power loads) to propel the flare. The cartridges are loaded into a cylinder that is installed in the launcher. Each cylinder holds nine cartridges. A flare is loaded into the barrel, the launcher is pointed in the desired direction, and the trigger is pulled. The cartridge fires, ignites the flare, and propels it to the ignition point. Up to nine flares may be fired before the cylinder must be removed and reloaded with new cartridges.

**Figure 4–1—An Orion flare launcher with an Orion 12-gauge flare.**



**Figure 4–2—A FireQuick flare launcher, 22-cal power loads, and a FireQuick flare.**



## ADVANTAGES AND DISADVANTAGES

### Using Flares and Flare Launchers

Advantages	Disadvantages
Easy to obtain	Some launchers are not designed for repeated firing
Lightweight and compact	Firing pins bend on some brands
Allow remote ignition in steep or inaccessible terrain	Frames may develop cracks
Easy to use and operate with minimum training	Very loud, can cause hearing damage if hearing protection is not worn
Allow firefighters to ignite fuels quickly inside the fireline to draw fire away from the fireline	Flares may cost more than \$3 each

## Sources of Equipment That Meet Standards

### Manufacturers of approved flares and launchers

FireQuick Products, Inc.  
1137 Red Rock Inyokern Rd.  
P.O. Box 910  
Inyokern, CA 93527  
Phone: 855-374-3473  
Fax: 760-377-5761  
Web site: <http://www.firequick.com>

Orion Safety Products  
3157 North 500 W.  
Peru, IN 46970  
Phone: 800-851-5260  
Fax: 765-473-3254  
Web site: <http://www.orionsignals.com>

## Situations Favorable for Flare Launcher Use

A flare and a flare launcher work well when:

- Burning dry, light, continuous ground fuels
- Burning fuels across a water barrier or in terrain that is steep, hazardous, or otherwise inaccessible
- Igniting fuels to draw flames away from the fireline

## Safety Requirements

Hazard analysis information for use of flares and flare launchers is provided in the “[Flare and Flare Launcher Resources](#)” section at the end of this chapter. Prepare and review your hazard analysis document before beginning work.

### Required Personal Protective Equipment (PPE)

- Hardhat
- Flame-resistant pants
- Flame-resistant shirt
- Leather gloves
- Approved boots
- Eye protection
- Hearing protection

### Transporting Flare Launchers

- Do not transport the flare launcher loaded with flares or cartridges.
- Do not transport the flare launcher on commercial aircraft.

### Transporting Cartridges

- Do not transport cartridges on commercial aircraft.
- Transport cartridges loose in original boxes, or other strong packages.
- Keep cartridges dry.

Refer to the *NWCG Standards for Aviation Transport of Hazardous Materials*, PMS 513, for additional information on transporting flare cartridges on Government contract helicopters.

### Transporting FireQuick Flares

#### GROUND TRANSPORTATION

- Transport flares in their original packaging if the total weight of all hazardous materials, including the flares, does not exceed 440 pounds. Other hazardous materials that must be included in the 440-pound limit include drip torch fuel, gasoline, and plastic spheres used for ground and aerial ignition.
- If the flares (in their original packaging) are packed in another package, such as a strong cardboard box, the total weight of each package cannot be more than 66 pounds.
- If more than 440 pounds of hazardous materials will be transported in a vehicle, the flares must be transported in their original packaging and packed in a strong package, such as a cardboard box. Each package cannot weigh more than 66 pounds.
- Do not transport flares with explosives, corrosive liquids, or poisonous gases and liquids.
- Do not transport flares in a vehicle’s passenger compartment.
- Keep flares dry.

#### **TRANSPORTATION BY A GOVERNMENT CONTRACT HELICOPTER**

- Transport flares in original packaging whenever possible.
- Do not transport broken flares.
- Do not transport flares where they could be exposed to batteries or battery fluids.
- Do not transport flares with explosives.
- Do not transport flares on commercial aircraft.

Refer to the *NWCG Standards for Aviation Transport of Hazardous Materials*, PMS 513, for additional information.

#### **Transporting Orion Flare Cartridges**

##### **GROUND TRANSPORTATION**

- Transport flare cartridges to the burn site in the manufacturer's original packaging.
- Do not transport flare cartridges in a vehicle's passenger compartment.
- Do not transport flare cartridges with explosives, corrosive liquids, or poisonous gases and liquids.
- Keep flare cartridges dry.

#### **TRANSPORTATION BY A GOVERNMENT CONTRACT HELICOPTER**

- Transport flares in the manufacturer's original packaging whenever possible.
- Do not transport flares where they could be exposed to batteries or battery fluids.
- Do not transport broken or damaged flare cartridges.
- Do not transport flares with explosives.
- Do not transport flare cartridges on commercial aircraft.

Refer to the *NWCG Standards for Aviation Transport of Hazardous Materials*, PMS 513, for further information.

## **Qualifications**

To be qualified to use flares and flare launchers for incidents or projects, individuals must meet prerequisites and training requirements.

### **Prerequisites**

For operators:

- Hold the position of Type 2 firefighter (FFT2) or prescribed fire crewmember (RXCM).

For instructors:

- Hold the position of FFT2 or RXCM.
- Demonstrate proficiency with flares and launchers.

### **Minimum Training**

For operators:

- Read the flare launcher manufacturer's training and operating instructions.
- Demonstrate proficiency with the flare launcher under the guidance of an experienced operator.

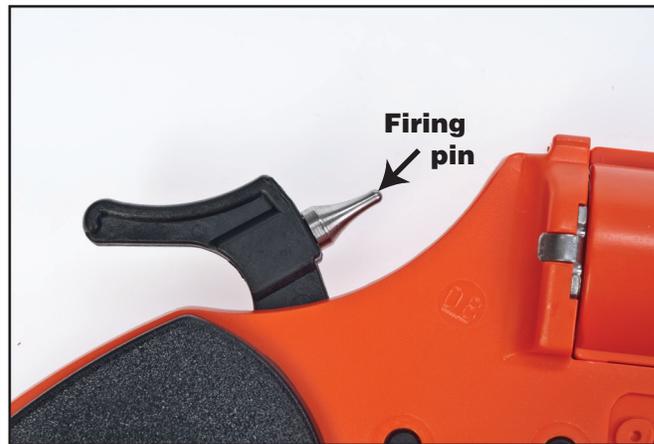
For instructors:

- Demonstrate proficiency with the flare launcher.

## Inspecting Flares and Flare Launchers

- Check flares or flare cartridges for visible defects, such as moisture or mechanical damage.
- Make sure that the flare launcher is not loaded with flares or cartridges.
- Ensure that the flare launcher is clean and operating properly.
- Check the launcher for cracking or damaged parts, such as bent firing pins (figure 4–3), and other defects. Do not use a defective launcher.
- Return defective launchers to the manufacturer for repair or replacement.

**Figure 4–3—Before using a flare launcher, inspect the firing pin to make sure it has not been bent.**



## Normal Operating Procedures for FireQuick Flare Systems

The operator and all personnel nearby must wear proper PPE, including eye and hearing protection.

### Preparing the Flare Launcher

- Make sure that the launcher is unloaded.
- Notify the appropriate supervisory personnel before beginning firing operations.

### Using the Flare Launcher

- Always keep the launcher pointed in a safe direction away from personnel and equipment. Treat the launcher as you would a loaded firearm.
- Remove the cylinder retaining pin from the launcher frame.
- Remove the cylinder (figure 4–4).
- Load the cylinder with the proper power load cartridge (figure 4–5). Cartridges come in several power levels identified by a load level number and color. The power level numbers for .22 caliber cartridges range from No. 1 (least powerful, gray with a brass case) to No. 7 (most powerful, gray with a nickel-colored case).

Figure 4-4—To load the FireQuick flare launcher, remove the cylinder.



Figure 4-5—Insert power loads into the cylinder.



- The manufacturer of the FireQuick Flare Systems recommends the following industrial loads:
  - No. 6 (purple with brass case) for most uses when launching Hot Shot flares (figures 4-6 and 4-7).
  - No. 7 (gray with nickel-colored case) when launching Stubby flares or when launching a Hot Shot flare for longer distances. These loads (figures 4-8 and 4-9) can damage the rear of the flare and cause more wear and tear on the launcher than No. 6 loads. No. 7 loads will damage the Launcher III. **Do not use No. 7 loads in the Launcher III.**
  - No. 5 (red with brass case) for less range than the No. 6 cartridges.
  - No. 4 (yellow with brass case) or lower power loads are not recommended because they will not shoot the flare far enough.
- Install the cylinder in the launcher's frame.
- Replace the cylinder retaining pin and ensure that it is properly installed.
- Attempt to rotate the cylinder. If the cylinder is properly installed, the cylinder lock will prevent the cylinder from rotating.
- **Do not place your finger near the trigger until you are prepared to fire.** This is especially important when loading a flare in the FireQuick launcher because the hammer on a FireQuick launcher does not have to be cocked to fire.
- Make sure that no one is downrange of the launcher and that everyone nearby is at least 5 feet behind you and wearing PPE, including hearing and eye protection.
- Make sure that the flares you are preparing to load are designed for the launcher. Never use flares in a launcher that was not designed for them.
- With the barrel pointed toward the area to be burned, load a flare—cap-end first—into the barrel (figure 4-10). Make sure the flare is completely seated in the barrel. Do not seat the flare with your hand or against your body. Use a solid object, such as a tree or rock, to seat the flare.
- Make sure no one is downrange of the launcher.
- Raise the launcher and point it toward the area you want to burn. A 45-degree launch angle provides the maximum distance and helps ensure that the flare ignites after it hits the ground. If the launch angle is steeper than 45 degrees, the flare may ignite before it hits the ground. If the launch angle is less than 45 degrees, the flare may ricochet off the ground or obstructions nearby.
- Don't launch flares toward obstructions, such as trees, that may send the flare ricocheting back toward you.

Figure 4-6—A box containing No. 6 power loads. This is the load that should normally be used to launch flares.

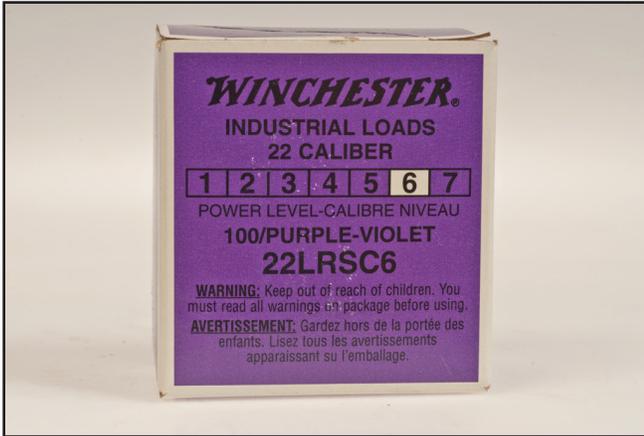


Figure 4-8—A box containing No. 7 (the most powerful) power loads. These loads are harder on the launcher than lighter loads and can damage the flare.



Figure 4-10—Loading a flare into the FireQuick launcher.



Figure 4-7—A No. 6 power load. The crimped end of the brass case is painted purple, indicating the power of the load.



Figure 4-9—A No. 7 power load. The crimped end of the nickel-plated case is painted gray, indicating the power of the load.





- Cock the hammer only when you are prepared to fire.
- Do not change locations while the hammer is cocked.
- If you do not fire the launcher, uncock the hammer before moving.
- Before firing, verbally notify all personnel in the area that you are about to fire by loudly saying “firing.”
- Pull the trigger to launch the flare (figure 4–11).
- Up to nine flares can be launched from a cylinder.
- When firing operations are complete, make sure the launcher is unloaded. Never transport or store a launcher loaded with either flares or cartridges.

**Figure 4–11—Launching a flare with the FireQuick flare launcher.**



### Spare Cylinders

Spare cylinders preloaded with flare cartridges can be carried to reduce the time required to reload the launcher.

## Emergency Operating Procedures for FireQuick Flare Systems

FireQuick Flare System operators need to know what to do in the following situations:

- Misfire (cartridge fails to fire)
  - Keep the launcher pointed downrange over the fire area. Notify all personnel in the immediate area by loudly saying “misfire.”
  - With the launcher pointed downrange, wait about 30 seconds to make sure the cartridge does not “hang fire.”
  - Repeat the launch procedure.
  - If the second cartridge does not fire, keep the launcher pointed downrange and wait at least 30 seconds.
  - Unload the flare and cartridges from the launcher.
  - Inspect the launcher for defects according to the *FireQuick Flare Systems User Training Workbook*.
- Fire
  - If a flare ignites in the barrel of the launcher, immediately discard the launcher, preferably inside the burn area, away from yourself and others.

## TROUBLESHOOTING

### FireQuick Flare System Troubleshooting Procedures

Malfunction	Likely problem	Corrective action
Flare departs launcher, travels a good distance, but does not ignite	Dud flare	Test other flares in the launcher to assess operation of the launcher.
Flare departs launcher, travels a short distance	Weak cartridge Flare not properly seated in barrel	Test other flares to assess the operation of the launcher. Make sure the flares are properly seated in launcher.
Flare does not depart launcher	Dud flare cartridge	Fire the next cartridge.
Flare does not depart launcher after several tries	Launcher firing pin damaged	Remove the cylinder, dry fire the launcher, and make sure that the firing pin is visible.
Cylinder will not rotate	Burr on cylinder	Remove the cylinder and lightly sand the ratcheted side to remove any burrs.
Trigger catches or does not fire properly	Launcher is dirty	Clean the launcher thoroughly, dry fire the launcher to check trigger operation.
	Firing pin is damaged	Send the launcher back to the manufacturer for repair.
Cartridge casing has expanded in cylinder after firing	Gas port has become fouled with soot	Remove the cylinder and clean the gas port using firearm cleaning solvent and a pipe cleaner.
Flare is difficult to insert into launcher	Residue buildup in launcher barrel	Use gun cleaning solvent and a small wire brush to clean the barrel.

## Normal Operating Procedures for Orion Flare Systems

The operator and all personnel must wear proper PPE, including eye and hearing protection.

### Preparing the Flare Launcher for Use

- Make sure the launcher is unloaded.
- Notify the appropriate supervisory personnel before firing operations begin.

### Using the Flare Launcher

- Make sure no one is downrange of the launcher and that everyone nearby is at least 5 feet behind you and wearing PPE, including hearing and eye protection.
- Keep your finger away from the trigger.
- With the barrel pointed toward the area to be burned, break open the launcher barrel and insert a flare cartridge. Make sure the flare cartridge is completely seated in the chamber (figure 4–12).
- Close the launcher barrel. The barrel should snap shut. If the barrel does not fully close, do not force it—replace the launcher.
- Make sure no one is downrange of the launcher.
- Raise the launcher and point it toward the intended target. A 45-degree launch angle provides the maximum distance and helps ensure that the flare ignites after it hits the ground. A launch angle that is too steep may cause the flare to ignite before it hits the ground. A launch angle that is too shallow may cause the flare to ricochet.
- Cock the hammer only when you are ready to fire.
- Do not change locations while the hammer is cocked.

- If you do not fire the launcher, uncock the hammer before moving.
- Before firing, verbally notify all personnel in the area that you are about to fire by loudly saying “firing.”
- Pull the trigger to launch the flare.
- Break open the barrel and remove the empty flare cartridge casing. Do not discard the empty casing in the burn area. Dispose of the casing properly.
- During prolonged firing operations, periodically inspect the launcher for cracking, damaged parts such as bent firing pins, and other defects. Do not use a defective launcher. Return defective launchers to the manufacturer for repair or replacement.
- When firing operations are complete, make sure that the flare launcher is unloaded.

**Figure 4-12—Loading an Orion flare launcher.**



## **Emergency Operating Procedures for Orion Flare Systems**

Orion Flare System operators need to know what to do in the following situations:

- Misfire (flare cartridge fails to fire)
  - Keep the launcher pointed downrange over the fire area. Notify all personnel in the immediate area by loudly saying “misfire.”
  - With the launcher pointed downrange, wait about 30 seconds to make sure the flare cartridge does not “hang fire.”
  - Remove the dud cartridge from the launcher.
  - Insert a new flare cartridge and attempt to launch a flare.
  - If the flare does not launch, keep the launcher pointed downrange for about 30 seconds before removing the cartridge from the launcher and inspecting the launcher for defects.
  - Dispose of defective cartridges properly.
- Fire
  - If a flare ignites in the barrel of the launcher, immediately discard the launcher, preferably inside the burn area, away from yourself and others.

## TROUBLESHOOTING

### Orion Flare System Troubleshooting Procedures

Malfunction	Likely problem	Corrective action
Flare departs launcher, travels a good distance, but does not ignite	Dud flare	Test other flares in the launcher.
Flare departs launcher, travels a short distance	Weak powder charge in flare cartridge	Test other flares in the launcher.
Flare does not depart launcher	Dud flare cartridge	Wait 30 seconds before removing the flare cartridge from the launcher. Insert a new flare cartridge and attempt to launch the flare. If the new flare cartridge does not fire, inspect the launcher's firing pin for damage. Replace the damaged launcher.
Flare cartridge is difficult to insert into launcher or will not chamber completely	Damaged flare cartridge Obstruction in chamber of launcher Dirty launcher	Inspect the flare cartridge for damage. Replace the damaged flare cartridge. Inspect the launcher for an obstruction in the chamber. Remove any obstruction or replace the launcher. Clean or replace the launcher.

## Maintenance and Storage

### Cleaning and Repair

- Make sure the launcher is not loaded with flares or flare cartridges.
- Inspect your launcher and check for worn parts, cracks, or other signs of excessive wear. Return damaged or worn launchers to the manufacturer for repair or replacement.
- Clean your launcher.
  - Clean the FireQuick flare launcher using firearms cleaning solvent.
  - Clean the Orion flare launcher using soap and water. Take care not to get soap and water in the firing mechanism. Do not use cleaning solvent on the Orion launcher; solvent could weaken the plastic.

### Launcher Replacement

- Orion launchers should be replaced annually.
- Old-style FireQuick launchers that use epoxy to seal the barrel shall be replaced because the epoxy can fail and injure the user (figures 4–13 and 4–14).

### Storing the Launcher

- Always store the launcher unloaded.
- Keep your launcher protected in a case or pouch to reduce risk of damage or unnecessary wear.
- Store the launcher in a dry area where access is controlled.

Figure 4-13—Brown epoxy used to seal the barrel of this FireQuick flare launcher can dislodge when the launcher is fired, injuring the user. This launcher should be replaced with a newer model that does not have epoxy sealing the barrel.



Figure 4-14—This is an example of a FireQuick flare launcher that does not have epoxy sealing the barrel.



### Storing Flares

- Maintain controlled access to flares (figure 4-15).
- Store flares in the original manufacturer's packaging in a cool, dry environment.
- Do not store flares near flammable liquids or other flammable materials.
- Keep the storage area free of sparks or heat sources; prohibit smoking within 50 feet (15 meters) of the storage area.
- Contact your hazardous materials coordinator for additional storage information.

Additional storage information can be found in NTDP's *Everyday HazMat User's Training Guide*.

Figure 4-15—This cabinet is labeled properly for storing flares.



## Disposing of Damaged or Dud Flares

- Always treat flares held for disposal as though they could ignite; follow the same safe storage instructions as for good flares.
- Flares held for disposal should be clearly marked as defective and stored separately from good flares.
- Call the manufacturer for specific disposal instructions and procedures. Check with your local unit or state safety officer for agency policy.

## Flare and Flare Launcher Resources

This section includes the following resources:

- Information for inclusion in a hazard analysis
- List of required safety data sheets
- Recommended spare parts
- Cache refurbishment
- Equipment standards for flares and flare launchers
- Contract equipment inspection checklist
- Flare and flare launcher references

## Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

Information for Flare and Flare Launcher Hazard Analyses		
Task	Hazards	Abatement actions
Loading the launcher	Pinched fingers	Take care when installing the cylinder of a Firequick launcher. Keep your fingers away from the chamber when closing the Orion launcher. Wear leather gloves.
	Accidental discharge of the launcher	Keep the launcher pointed in the direction of the intended target area and away from yourself and others. Keep your fingers away from the launcher trigger.
Handling a loaded launcher	Accidental discharge of the launcher	Keep the launcher pointed in the direction of the intended target area and away from yourself and others. Keep your fingers away from the launcher trigger.
Launching flares	Loud noise	Wear hearing protection.
	Unburned powder escaping from the gap between the cylinder and the barrel of the FireQuick launcher	Wear eye protection. Wear gloves. Keep all bystanders at least 5 feet behind the operator of the launcher.
	Potential for launcher failure	Wear all PPE, including eye protection, gloves, a long-sleeve shirt, a hardhat, hearing protection, and boots.
	Premature ignition of the flare as it departs from the launcher	Wear all PPE, including eye protection, gloves, a long-sleeve shirt, hardhat, hearing protection, and boots.
	Misfire of the power cartridge or flare cartridge	Keep the launcher pointed in a safe direction and wait a minimum of 30 seconds. After at least 30 seconds, pull the hammer back and attempt to launch the flare again. If the flare does not launch, wait another 30 seconds and then unload the launcher. Inspect the launcher for damage.
	Dud flare	Wait at least 30 seconds before retrieving the flare for disposal.

## List of Required Safety Data Sheets

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for flares and flare launchers include:

- FireQuick flare
- Orion flare
- Cartridges (industrial loads) for FireQuick Flare System

### Recommended Spare Parts

- FireQuick Launcher
  - Spare cylinder
- Orion Launcher
  - Spare launcher

### Cache Refurbishment Standards

#### FIRE EQUIPMENT STORAGE AND REFURBISHING STANDARDS

#### ITEM: FLARE SYSTEM

- Cache Items
  - Hot Shot flares
  - No. 6 power cartridges
  - Spare cylinders
- Initial Inspection/Disposal Criteria
  - Inspect the launcher for damage; replace damaged parts or return to the factory or manufacturer for repair.
- Refurbishing Procedures
  - Clean the launcher

### Equipment Standards for Flares and Flare Launchers

#### FLARES

- Packaged, labeled, and marked in accordance with DOT shipping requirements.
- Must have an SDS available.
- Moisture resistant.
- Must reliably ignite 1-hour fuels, such as grass, needles, and leaves.
- Have a shelf life of at least 2 years.

The flares and cartridges must not be considered ammunition or explosives by the Bureau of Alcohol, Tobacco, Firearms and Explosives. A letter from BATFE or other documentation stating the flares and/or cartridges are not ammunition or explosives must be supplied by the manufacturer or distributor.

## Flare Launchers

- Off-the-shelf design. (Both the launcher and flares must be readily available.)
- Designed for multiple launches.
- Easy to carry (about the size of a handgun).
- Usable by people with small hands.
- Easy to use with gloved hands.
- Trigger pull: at least 4 pounds.
- Weight: about 3 pounds or less.
- Range: about 300 feet.
- Accuracy: plus or minus 10 degrees under calm conditions.

The launcher must not be considered a firearm by the Bureau of Alcohol, Tobacco, Firearms and Explosives. A letter from BATFE or other documentation stating the launcher is not a firearm must be supplied by the manufacturer or distributor.

## Contract Equipment Inspection Checklist

- Contractor flares and launchers must meet the standards established in this chapter.

## Flare and Flare Launcher References

See [appendix B](#) for additional ground ignition references.

*FireQuick Flare Systems User Training Workbook*, available from FireQuick Products, Inc., 855–374–3473

*Everyday HazMat User's Training Guide*, 0471–2810–MTDC, available at [<https://www.fs.usda.gov/t-d/everyday\\_hazmat>](https://www.fs.usda.gov/t-d/everyday_hazmat)





## Chapter 5—Fusees

### Equipment Description

A fusee is a handheld disposable ground ignition device with a self-contained ignition system (figure 5–1). Like common road flares, fusees generate a flame about 5 inches long. Fusees are effective for igniting vegetation during firing operations and are commonly carried by firefighters, who use them if they need to create emergency safety zones.

### Sources of Equipment That Meet Specifications

Fusees must meet the requirements of the latest revision of Forest Service Specification 5100–360 (figure 5–2). Do not use road flares or other signaling devices for ground ignition.

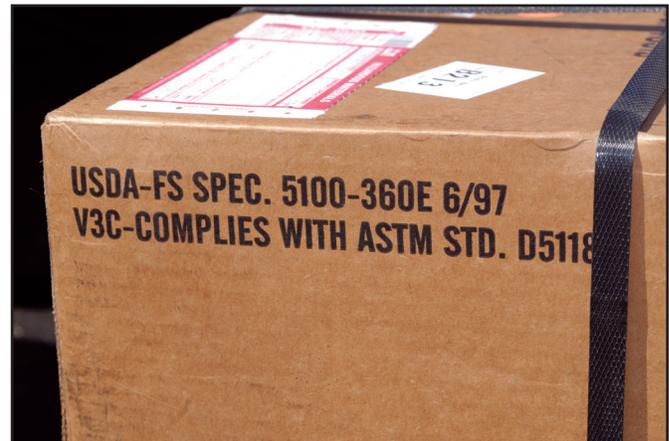
New fusees are available from DLA (NSN 6260-00-294-1279) and from the National Interagency Support Caches (NFES 0105).

Fusees no longer contain the chemical potassium perchlorate. Before use, fusees with the new chemical composition (labeled “NPC” on the SDS and noted on the fusee body) should be stored in the plastic bag in the original box.

Figure 5–1—A burning fusee shortly after being ignited.



Figure 5–2—Fusees must meet the requirements of Forest Service Specification 5100–360.



### Situations Favorable for Fusee Use

Fusees may work well when:

- Burning grass, pine needles, leaves, brush, and similar dry fuels that ignite readily and radiate enough heat to sustain combustion
- Creating emergency safety zones

## ADVANTAGES AND DISADVANTAGES

### Using Fusees

Advantages	Disadvantages
Easy to obtain from most fire caches	Not effective in wet or noncontinuous fuels
Inexpensive, easy to use, portable	Will not function if they become wet
Effective in all continuous fuel types	Cannot be transported on airlines; require disclosure to helicopter pilots if transported in contract helicopters
Lightweight and have a weather-resistant wax coating	
Can be used from a utility vehicle or while walking	Special transportation requirements because they are a hazardous material
Can be used to light other ignition devices	Burn at temperatures higher than 1,400 °F
Can be carried in fireline packs	Emit noxious fumes
Burn for up to 10 minutes	Drip and splatter molten material that can burn through protective clothing
Can be connected to other fusees or a stick, keeping the burning fusee away from your body	Hard to extinguish once they are ignited, but may extinguish when thrown if they are not fully burning
Safe and stable to store, requiring little storage space	

## Safety Requirements

Hazard analysis information for the use of fusees is provided in the “[Fusee Resources](#)” section at the end of this chapter. Prepare and review your hazard analysis document before beginning work.

### Required Personal Protective Equipment (PPE)

- Hardhat
- Flame-resistant pants
- Flame-resistant shirt
- Leather gloves
- Approved boots
- Eye protection

### Transporting Fusees

Do not transport fusees that are damaged, broken, that do not have the protective striker caps installed (figure 5–3), or that are in sealed containers that will not release pressure if the fusees ignite. Do not transport fusees with explosives, poisonous gases, or poisonous or corrosive liquids.

- Transport fusees in a container, box, or pack. Use the original shipping box whenever possible (figure 5–4).
- Pack the fusees so they cannot shift around inside the packaging during transport.
- Secure the package so it won’t move around in the vehicle.
- Protect the package from puncture, wetting, ignition sources, and impact.

Figure 5-3—A fusee with the protective striker cap (left) removed. Do not transport fusees without the protective striker cap installed.

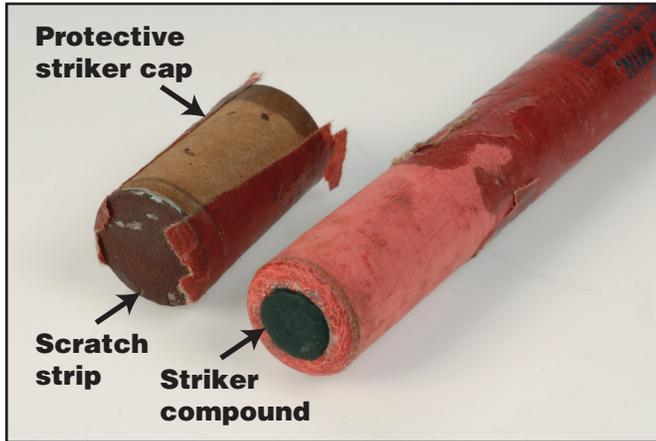


Figure 5-4—Use the original shipping box (shown) to transport fusees whenever possible.



Fusees may not be transported on commercial airlines. Fusees are classified by the DOT as a flammable solid. No more than 440 pounds of hazardous materials, including fusees, should be transported in one vehicle.

If you are transporting more than 440 pounds combined total weight of fusees and other hazardous materials, DOT hazardous material training is required and you must carry shipping papers, the SDS, and a copy of the *Emergency Response Guidebook* in the vehicle.

If you are transporting 1,001 pounds or more of fusees and other hazardous materials, you must have a commercial driver's license in addition to DOT hazardous materials training. Shipping papers, the SDS, and a copy of the *Emergency Response Guidebook* must be carried in the vehicle, and the vehicle must be placarded.

## Qualifications

To be qualified to use a fusee for incident or project work, individuals must meet prerequisites and training requirements.

### Prerequisites

For operators:

- Hold the position of Type 2 firefighter (FFT2) or prescribed fire crewmember (RXCM).

For instructors:

- Hold the position of FFT2 or RXCM.
- Demonstrate proficiency with a fusee.

### Minimum Training

For operators:

- Read and understand the information in this chapter.
- Read the manufacturer's operating instructions.
- Receive operational training from an instructor.

For instructors:

- Demonstrate proficiency with a fusee.

## Safety Precautions

- Always read and follow the fusee manufacturer's warnings, precautions, and safety instructions.
- Inspect each fusee for damage and for missing protective striker caps.
- Do not use fusees that are damaged.
- Do not transport fusees that are missing their protective striker caps.
- Do not expose fusees to open flames or temperatures higher than 167 °F.
- Always hold burning fusees downwind and downward, well away from your body. Fusees drip molten materials (figure 5–5) that can burn through protective clothing and cause serious burns.
- Do not breathe the fumes. Fusees emit noxious smoke.
- Do not look directly at the flames of fusees.
- Do not ignite a fusee until you are ready to use it.
- Keep burning fusees well away from people and other objects.
- Do not take fusees inside your fire shelter during deployment.

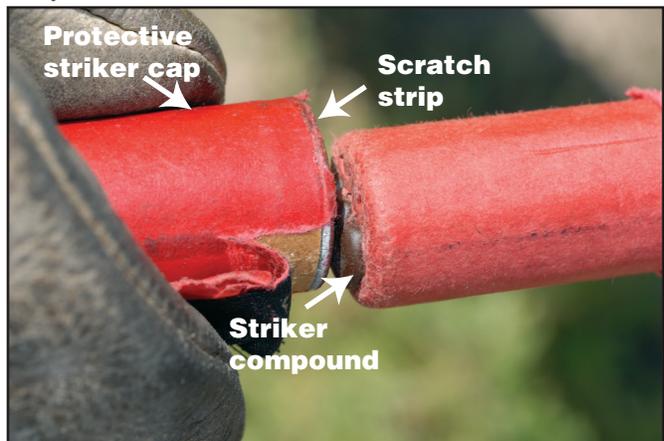
## Normal Operating Procedures for Fusees

- Remove the protective striker cap (figure 5–6) and ignite the fusee away from your body.
- Once a fusee has been lit, never carry it outside the area to be burned because molten materials can drip and start fires.
- Use a stick or other fusees as an extension handle (figure 5–7) to keep burning fusees away from your body during burning operations.
- When throwing a fusee, make sure all other people are away from you so they will not be hit with molten material.
- Make sure fusees are fully burning before throwing them.
- Allow fusees to burn completely (figure 5–8).
- Pick up all the used striker caps and dispose of them properly.

Figure 5–5—Fusees drip molten material that can cause serious burns.



Figure 5–6—Use the striker on the end of the protective cap to ignite the fusee. Always strike the fusee away from your body.



**Figure 5-7**—Several fusees may be joined together to form an extension handle to keep burning fusees away from your body.



**Figure 5-8**—Allow fusees to burn completely. The ferrule usually does not burn completely.



## Storage

- Store fusees in a clean, dry place at temperatures from 40 to 90 °F.
- Avoid storing fusees at temperatures higher than 120 °F for longer than 1 week. Normal recommended storage temperatures are from 40 to 90 °F.
- Never store fusees near an ignition source (such as sparks or flames).
- Keep fusees away from oil and water and out of direct sunlight.
- Rotate the stock of fusees to keep a fresh supply.
- Do not stack heavy items on fusees.
- When possible, store fusees in the plastic bag in the original box.

For further storage information, consult the *Everyday HazMat User's Training Guide*, agency policy, and your local hazardous materials coordinator.

## Disposal of Fusees

Dispose of fusees in accordance with federal, state, and local requirements. If you are unsure about these requirements, contact a hazardous waste disposal contractor.

## Fusee Resources

This section includes the following resources:

- Information for inclusion in a hazard analysis
- List of required safety data sheets
- Equipment specifications for fusees
- Fusee references

### Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

Information for Fusee Hazard Analyses		
Task	Hazards	Abatement actions
Igniting and using the fusee	Burns	Wear gloves, flame-resistant clothing, boots, a hardhat, and eye protection.
		Point the fusee away from your face and body when igniting it.
		Keep the burning fusee away from other people and objects.
		Keep fusees away from heat sources to prevent fusees from self-igniting.
Using the fusee	Noxious smoke	Hold the fusee away and downwind from your body.

### List of Required Safety Data Sheets

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for fusees include:

- Orion fusee

The latest version of the fusee safety data sheet is available on the Orion Web site at <http://www.orionsignals.com/sds-sheets.html>.

### Equipment Specifications for Fusees

The equipment specification for fusees are available as:

*Fusee, Backfiring 5100-360* at <https://www.fs.usda.gov/t-d/programs/fire/specs.htm>.

### Fusee References

See [appendix B](#) for additional ground ignition references.

*Everyday HazMat User's Training Guide*, 0471–2810–MTDC, available at [https://www.fs.usda.gov/t-d/everyday\\_hazmat](https://www.fs.usda.gov/t-d/everyday_hazmat).

*Specification 5100-360, Fusee, Backfiring*, available at <https://www.fs.usda.gov/t-d/programs/fire/specs.htm>.



## Chapter 6—Gelled Fuel Blivets

### Equipment Description

In the past, blivets were made locally by filling plastic bags with gelled gasoline. Because of the hazards of mixing, packaging, and transporting gelled gasoline, commercial blivets are a better alternative. Commercial blivets are about 10 inches long and 1¾ inches in diameter and contain an alcohol-based gel (figure 6–1). They may be ignited with a drip torch, fusee, or other means and will produce a strong, open flame that lasts about 20 minutes.

**Figure 6–1—This commercially available blivet is called a FireSnake or Heat Source Slash Burner.**



### Sources of Equipment That Meet Standards

Heat Source Slash Burners are one commercial brand of gelled fuel blivets. These blivets, also known as FireSnakes, are available from Western Fire Supply at <http://stores.westernfiresupply.net/heat-source-slash-burner-fire-snake/>:

Western Fire Supply  
 11476 Sunrise Gold Circle, Unit 1  
 Rancho Cordova, CA 96742  
 Phone: 866–966–3473  
 Fax: 916–851–9006

#### ADVANTAGES AND DISADVANTAGES

##### Using Gelled Fuel Blivets

Advantages	Disadvantages
Long-lasting flame ignites slash piles that are damp or that do not have enough fine fuels to ignite with a drip torch	The concentrated heat source is not suited for igniting large areas
Easily transported on foot; small enough that several can be carried in a pack	Blivets may leak and contaminate a pack
	Locally made blivets require highly flammable fuel to be mixed with a gelling agent



## Situations Favorable for Gelled Fuel Blivet Use

A gelled fuel blivet may work well when:

- Slash piles or concentrated pockets of fuel do not have enough fine fuels to ignite with a drip torch
- Burning during wet or cold weather

### Safety Requirements

Hazard analysis information for gelled fuel blivet operations is provided in the “[Gelled Fuel Blivet Resources](#)” section at the end of this chapter. Prepare and review your hazard analysis document before beginning work.

### Required Personal Protective Equipment (PPE)

- Hardhat
- Flame-resistant pants
- Flame-resistant shirt
- Leather gloves
- Approved boots
- Eye protection

### Transporting Gelled Fuel Blivets

Heat Source Slash Burners and other gelled fuel blivets are Packing Group II flammable liquids (Class 3).

- Transport blivets in the original steel pails (figure 6–2) that the distributor shipped them in.
- If the pails have been discarded, transport the blivets in DOT specification containers, such as UN 1A2 drums or steel pails 5 gallons or smaller.
- Install a FLAMMABLE LIQUID label (figure 6–3) on the pail or drum if the drum or pail does not already have one.
- For Heat Source Slash Burners only, mark the drum or pail with ISOPROPANOL if the drum or pail has not already been marked by the vendor.
- Include the required SDS with each shipment.
- Make sure that all fuel containers are properly secured during transportation.
- Avoid transporting more than 440 pounds of hazardous materials, including blivets, in one vehicle. All hazardous materials must be in containers smaller than 8 gallons and weigh 66 pounds or less.

If you are transporting more than 440 pounds of blivets or other hazardous materials or if any fuel container is larger than 8 gallons or weighs more than 66 pounds, DOT hazardous materials training is required. Shipping papers and a copy of the *Emergency Response Guidebook* must be carried in the vehicle.

If you are transporting 1,001 pounds or more of fuel blivets or if any container is larger than 119 gallons, the driver must have a commercial driver’s license (CDL) and DOT hazardous materials training. Shipping papers and a copy of the *Emergency Response Guidebook* must be carried in the vehicle, and the vehicle must be placarded.

**Figure 6–2—Transport blivets in a UN 1A2 steel pail or another container that meets DOT specifications.**



**Figure 6–3—Make sure a FLAMMABLE LIQUID label is installed on pails used to carry blivets.**



### **Qualifications**

To be qualified to use gelled fuel blivets for incidents or projects, individuals must meet prerequisites and training requirements.

### **Prerequisites**

For operators:

- Hold the position of Type 2 firefighter (FFT2) or prescribed fire crewmember (RXCM).

For instructors:

- Hold the position of FFT2 or RXCM.
- Demonstrate proficiency with gelled fuel blivets.

### **Minimum Training**

For operators:

- Read and understand the information in this chapter.
- Read the blivet manufacturer's operating instructions.
- Receive operational training from an instructor.

For instructors:

- Demonstrate proficiency with gelled fuel blivets.

## Inspecting Gelled Fuel Blivets

Before gelled fuel blivets are used, inspect each blivet for leakage and damage.

## Normal Operating Procedures for Gelled Fuel Blivets

The operator must wear the proper PPE.

### Preparing Blivets for Use

Line a pack with plastic to prevent blivets from soaking the pack if they leak.

- Remove the blivets from the steel pail they're shipped in (figure 6–4).
- Inspect each blivet to make sure it's not leaking before putting the blivet in the pack.
- Seal each leaking blivet in a separate plastic bag. Use these blivets first.
- Do not allow gel to leak on clothing or skin.

### Using Blivets

- Remove the blivet from the pack and place the blivet where fuel is closely packed.
- Ignite the blivet with a drip torch, fusee, or other ignition device (figure 6–5).
- Make sure that the blivet has ignited (figure 6–6).
- Verify that the blivet has ignited the fuel in the pile before moving to the next location.

### Preparing Blivets for Transportation and Storage

- After burning operations are complete, remove the unused blivets from the pack and return them to the pail they were shipped in.
- Once all blivets have been returned to the pail they were shipped in, seal the pail for transport and storage (figure 6–7).

**Figure 6–4—Put blivets inside a plastic bag before carrying them in the field.**



**Figure 6–5—Blivets can be ignited with a drip torch.**



Figure 6-6—This blivet is completely ignited.



Figure 6-7—This steel pail is properly sealed for transport and storage.



## Maintenance and Storage

Store the unused blivets inside their shipping pails in a storage area for flammable materials.

## Gelled Fuel Blivet Resources

This section includes the following resources:

- Information for inclusion in a hazard analysis
- List of required safety data sheets
- Equipment standards for gelled fuel blivets
- Contract equipment inspection checklist
- Gelled fuel blivet references

## Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

Information for Gelled Fuel Blivet Hazard Analyses		
Task	Hazards	Abatement actions
Transporting blivets	Container leakage, identification of contents	Use only DOT-specification containers for transporting blivets. Properly seal containers before transporting blivets. Properly label and mark containers.
Using blivets	Exposure to gelled fuel	Inspect blivets for leaks before use. Place leaking blivets in a plastic bag; make sure that the bag does not leak. Use plastic to line a pack or use a plastic bag inside the carrying bag when carrying the blivets in the field.
	Burns	Wear proper PPE, including leather gloves. Ensure PPE does not become contaminated with fuel. Set the blivet in place before igniting it. Do not attempt to move or throw burning blivets.

### List of Required Safety Data Sheets

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for gelled fuel blivets include:

- FireSnake/Heat Source Slash Burner

### Equipment Standards for Gelled Fuel Blivets

- The blivet casing must be compatible with the gel and must not degrade because of contact with the gel.
- The casing must be sealed so the blivet does not leak.
- The casing must be durable enough to withstand normal transportation and handling.
- A drip torch should be able to ignite the casing.
- Blivets must be small enough that several can be carried in a pack or carrying bag.
- Blivets must not “flash” when ignited.
- Blivets must burn for at least 15 minutes.
- The flame from the blivet must be able to ignite 10-hour fuels, such as 1-inch diameter branches.

### Contract Equipment Inspection Checklist

- Contract gelled fuel blivets must meet the standards established in this chapter.

### Gelled Fuel Blivet References

See [appendix B](#) for additional ground ignition references.

*Everyday HazMat User’s Training Guide*, 0471–2810–MTDC, available at [https://www.fs.usda.gov/t-d/everyday\\_hazmat](https://www.fs.usda.gov/t-d/everyday_hazmat).



# Chapter 7—Plastic Spheres and Launchers

## Equipment Description

Plastic spheres, originally developed for aerial ignition systems, have been adapted for ground ignition. Each sphere contains potassium permanganate, an oxidizer. During burning operations, the sphere is injected with ethylene glycol (automotive antifreeze). After about 20 seconds, a chemical reaction ignites the plastic in the sphere (figure 7–1). The burning sphere ignites the surrounding vegetation.

Three manufacturers make plastic spheres that can be used for ground ignition. All of these spheres contain about 3 to 4 grams of potassium permanganate. The pink-and-white spheres manufactured by SEI Industries Ltd. and the white spheres manufactured for Aerostat, Inc. are 1¼ inches in diameter. PremoFire spheres, which are no longer being manufactured but are in circulation, are 1¼ inches in diameter. The orange-and-white plastic spheres manufactured by SEI Industries Ltd. are 1 inch in diameter and the red-and-clear plastic spheres manufactured by Firecraft Products, Inc. are 1⅛ inches in diameter (figure 7–2). If you are using a commercially produced sphere launcher, make sure you use the proper spheres.

Figure 7–1—A burning plastic sphere.



Figure 7–2—Plastic spheres shown from left to right and top to bottom: SEI Dragon Egg, Aerostat PSDS, SEI Premo Fireball, PremoFire sphere, and Firecraft Spitball.



### ADVANTAGES AND DISADVANTAGES

#### Using Plastic Spheres and Launchers

Advantages	Disadvantages
Plastic spheres allow remote ignition in steep or inaccessible terrain	Plastic spheres do not burn as intensely as flares or other types of ignition systems, which can limit the sphere's effectiveness in certain types of vegetation
Plastic spheres cost much less than flares (about 25 cents per sphere compared to about \$5 per flare)	Plastic sphere launchers are not as convenient to carry as flare launchers
Plastic spheres work well in 1-hour fuels, such as grass, needles, and leaves, and are good for understory burning	Plastic sphere launchers can be three times more expensive than flare launchers

Slingshots, available at most sporting goods stores, can be used to launch plastic spheres (figure 7–3). To make it easier to inject ethylene glycol, drill a hole into the plastic sphere and cover the hole with Cellophane tape. The sphere may be injected through the tape using a syringe filled with ethylene glycol. You will need to inject about 1 cubic centimeter of ethylene glycol. Load the sphere into the slingshot and shoot it 150 to 200 feet toward the area you want to burn.

Field Support Services of Chamblee, GA, has developed the PyroShot plastic sphere launcher, which uses compressed springs to launch SEI Dragon Egg plastic spheres (figure 7–4). The launcher’s plastic reservoir is filled with ethylene glycol and the hopper is filled with plastic spheres. The operator points the launcher in the desired direction, pulls back on the slide, and pushes the slide forward. The launcher injects the sphere with ethylene glycol and propels it about 50 feet.

**Figure 7–3—Slingshots may be used to launch plastic spheres.**



**Figure 7–4—The PyroShot plastic sphere launcher.**



The PyroShot HS (figures 7–5 and 7–6), also developed by Field Support Services, is a handheld plastic sphere launcher that uses nonflammable compressed gas, such as air or carbon dioxide, to propel SEI Dragon Egg plastic spheres. The launcher’s plastic reservoir is filled with ethylene glycol and the hopper is filled with plastic spheres. The operator points the launcher in the desired direction, prepares the launcher according to the model instructions, and then depresses the trigger to launch the sphere. Once a sphere is injected with ethylene glycol, it must be launched; do not retain an injected sphere in the launcher. The launcher can propel a sphere about 300 feet, depending on the gas pressure setting.

The PyroShot HS needs to be kept clean to prevent potassium permanganate and glycol from building up between the priming and firing chambers. Clean the residue at least at the end of each day or when spheres hesitate to fall into the chamber.

The compressed gas causes the PyroShot HS to launch plastic spheres with considerable power. Additional caution should be used to avoid injuring others and to prevent igniting areas outside the burn area.

The SEI Green Dragon (figure 7–7) is a plastic sphere launcher designed to be mounted on a wide range of vehicles and to use nonflammable compressed gas, such as air or carbon dioxide, to propel SEI Dragon Egg plastic spheres. The launcher can propel a sphere about 200 feet, depending on the gas pressure setting.

The Firecraft Products, Inc. Zinger (figure 7–8) is a plastic sphere launcher designed to be mounted on a receiver hitch and propel Firecraft Products, Inc. plastic spheres called “Spitballs.” The launcher can propel a sphere about 150 feet, depending on the launcher speed setting.

Figure 7–5—The PyroShot HS plastic sphere launcher with an optional 150-sphere hopper.

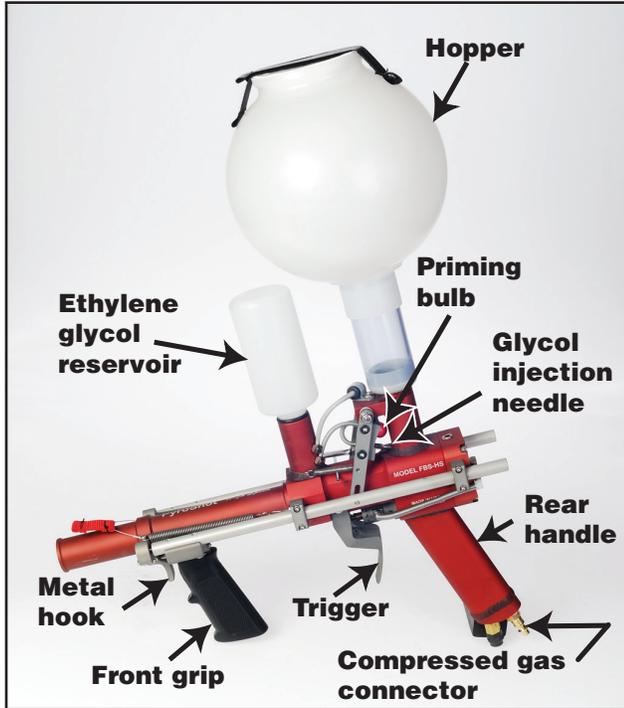


Figure 7–6—A newer version PyroShot HS plastic sphere launcher.



Figure 7–7—The SEI Green Dragon plastic sphere launcher mounted on a UTV.



Fig 7–8—The Firecraft Products, Inc. Zinger mounted on the front receiver hitch of a utility-terrain vehicle.





## Sources of Equipment That Meet Standards

### Plastic Spheres

#### AEROSTAT

Aerostat, Inc. plastic spheres are no longer allowed for aerial ignition because of flight safety concerns. They should not be purchased for ground ignition to prevent mixing the supply with aerial ignition resources.

#### PREMO

##### *Distributor*

Fire and Aviation Resource Services  
200 Embler Two Road  
Alexander, NC 28701  
Phone: 828-775-1871

#### SEI

##### *Manufacturer*

SEI Industries Ltd.  
7400 Wilson Ave.  
Delta, BC, Canada V4G 1E5

##### *Distributors*

Field Support Services  
2001 Flightway Dr.  
Chamblee, GA 30341  
Phone: 770-454-1130

Type One Incident Support, Inc.  
P.O. Box 8209  
Bend, OR 97708-8209  
Phone: 541-330-4340

##### *Manufacturer and Distributor*

Firecraft Products, Inc.  
96 Hodgson Road  
Fredericton, NB, Canada E3C 2G4  
Phone: 506-462-7245

### Ethylene Glycol Antifreeze

Use ethylene glycol automotive antifreeze or laboratory-grade ethylene glycol. Do not use the propylene glycol antifreeze that is often advertised as being environmentally safe.

## **Plastic Sphere Launchers**

### **PYROSHOT PLASTIC SPHERE LAUNCHER**

#### *Manufacturer*

Field Support Services  
2001 Flightway Dr.  
Chamblee, GA 30341  
Phone: 770-454-1130

#### *Distributors*

Field Support Services  
2001 Flightway Dr.  
Chamblee, GA 30341  
Phone: 770-454-1130

Type One Incident Support, Inc.  
P.O. Box 8209  
Bend, OR 97708-8209  
Phone: 541-330-4340

### **GREEN DRAGON PLASTIC SPHERE LAUNCHER**

#### *Manufacturer*

SEI Industries Ltd.  
7400 Wilson Ave.  
Delta, BC, Canada V4G 1E5  
Phone: 604-946-3131

#### *Distributors*

Field Support Services  
2001 Flightway Dr.  
Chamblee, GA 30341  
Phone: 770-454-1130

Type One Incident Support, Inc.  
P.O. Box 8209  
Bend, OR 97708-8209  
Phone: 541-330-4340

### **SPITFIRE WITH BALL-THROWER PLASTIC SPHERE LAUNCHER**

#### *Manufacturer and Distributor*

Firecraft Products, Inc.  
96 Hodgson Road  
Fredericton, NB, Canada E3C 2G4  
Phone: 506-462-7245

## Situations Favorable for Plastic Sphere Use

Plastic spheres may work well when:

- Burning dry, light fuels, such as grasses, needles, and leaves.
- Burning areas where foot access is limited, such as canals, cliffs, or areas of thick vegetation.

## Safety Requirements

Hazard analysis information for plastic spheres and launchers is provided in the “[Plastic Sphere Resources](#)” section at the end of this chapter. Prepare and review your hazard analysis before beginning work.

- The operator and everyone nearby shall be wearing PPE, including eye protection.
- Always keep the launcher or slingshot pointed away from all personnel and equipment.
- Do not inject a sphere with antifreeze until the moment you are ready to launch it.
- Launch all spheres immediately after injecting them with ethylene glycol. Do not retain an injected sphere in the launcher.
- Use the proper size sphere for the launcher.
- Ethylene glycol is a harmful substance readily consumed by livestock, pets, and wildlife. Keep it secured in closed containers and clean up spills immediately.

## Required Personal Protective Equipment (PPE)

- Hardhat
- Flame-resistant pants
- Flame-resistant shirt
- Leather gloves
- Approved boots
- Eye protection

## Recommended PPE

- Nitrile gloves (when handling antifreeze)

## Transporting Plastic Spheres and Ethylene Glycol Antifreeze

### TRANSPORTATION IN VEHICLES—PLASTIC SPHERES

- The potassium permanganate in plastic spheres is classified by the DOT as a Division 5.1 Oxidizer.
- Transport plastic spheres in the manufacturer’s original boxes.
- Do not transport plastic spheres in the same compartment as ethylene glycol or fuel.
- Do not transport plastic spheres with explosives, poisonous gases, or poisonous liquids.

A total of no more than 440 pounds of hazardous materials, such as gasoline, drip torch fuel, diesel, fusees, and plastic spheres, should be carried in one vehicle.

If plastic spheres must be transported with flammable liquids (such as gasoline) or corrosive liquids (such as Flash 21 gelling agent), they must be separated so that the contents from any leaking package cannot contact the contents of any other package.

#### TRANSPORTATION IN VEHICLES—ETHYLENE GLYCOL ANTIFREEZE

- Transport antifreeze in the manufacturer's original containers.
- Make sure that the containers do not leak before transporting them.
- Secure containers so they will remain upright during transport.
- Do not transport antifreeze in the same compartment as plastic spheres.

#### TRANSPORTATION IN AIRCRAFT

- Separate plastic spheres from antifreeze (glycol) containers so that the contents from any leaking container of plastic spheres cannot contact the contents of any leaking container of antifreeze.
- Do not transport plastic spheres where they could be exposed to batteries or battery fluids.
- Do not transport plastic spheres with explosives.

For more information, refer to the *NWCG Standards for Aviation Transport of Hazardous Materials*, PMS 513.

## Qualifications

To be qualified to use plastic spheres and launchers at incidents or during projects, operators must meet prerequisites and training requirements.

### Prerequisites

For operators:

- Hold the position of Type 2 firefighter (FFT2) or prescribed fire crewmember (RXCM).

For instructors:

- Hold the position of FFT2 or RXCM.
- Demonstrate proficiency with a plastic sphere launcher.

### Minimum Training

For operators:

- Read and understand the information in this chapter.
- Read the plastic sphere launcher manufacturer's operating instructions.
- Demonstrate proficiency annually in operating, maintaining, and troubleshooting a plastic sphere launcher under the guidance of an experienced operator.

For instructors:

- Be selected by the local fire management officer or the officer's designee.
- Demonstrate proficiency annually in operating, maintaining, and troubleshooting a plastic sphere launcher.

## Inspecting Plastic Spheres and Launchers

Before plastic spheres and launchers are used, the equipment must be inspected and readied for the field.

### **Plastic Sphere Inspections**

- Inspect spheres for cracks, defective seams, breakage, and other damage. Do not use damaged spheres.
- Make sure that the potassium permanganate is granulated and has not formed a solid mass inside the sphere.

### **Slingshot (Launcher) Inspections**

- Inspect the rubber tubing for brittleness, weather checking, cuts, and other damage. Replace rubber tubing as needed.
- Inspect the handle for bends, breakage, and other damage. Repair or replace the slingshot as necessary.

### **Plastic Sphere Launcher Inspections**

- Inspect the launcher following the instructions in the inspection section of the launcher operator's manual.
- Repair the launcher as necessary before use.

## **Normal Operating Procedures for Slingshots**

- If you're using a sling shot, drill holes in the spheres so you can inject ethylene glycol. Here's how:
  - Prepare a wooden block to support the sphere by drilling a hole smaller than the sphere (figure 7–9).
  - When drilling the spheres, use a drill bit about twice the diameter of the needle that you will use to inject the spheres.
  - Drill a single hole through one side of each sphere, using a drill press if possible. Make sure the surface surrounding the hole is smooth.
  - Cover each hole with Cellophane tape.
- Use a two-person team: one person to prime the spheres and the other to launch them.
- The person who will launch the spheres gets the slingshot ready.
- The person priming the spheres injects about 1 cubic centimeter of ethylene glycol and immediately hands the primed sphere to the person with the slingshot.
- The person with the slingshot loads the sphere and launches it immediately.

## **Emergency Operating Procedures for Slingshots**

If there is a delay launching a sphere and the sphere begins to ignite, drop the sphere on the ground. Let the sphere burn itself out or extinguish it with dirt or water.

## **Normal Operating Procedures for Plastic Sphere Launchers**

- Follow the product-specific setup instructions from the manufacturer.
- Fill the glycol bottle with ethylene glycol.
- Prime the glycol pump.
- Fill the hopper with the proper plastic spheres.

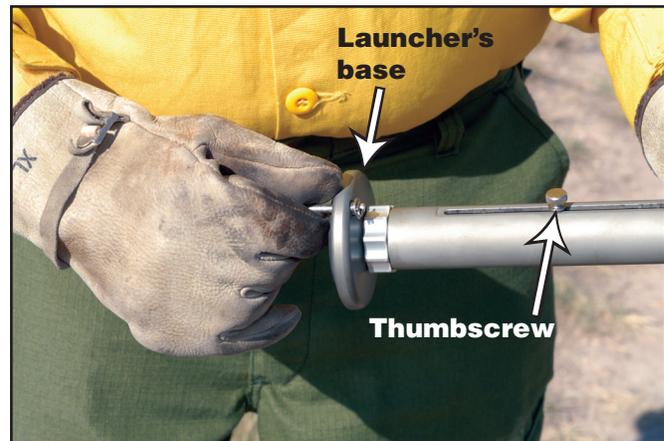
- With the launcher pointed in the direction of the target area, operate the launcher according to the launcher model instructions (figure 7–10).
- Excessive compressed gas pressure will cause erratic flight of the spheres.
- Many launchers will pump glycol whether or not a sphere has been loaded. Make sure that the launcher does not run out of spheres while it has ethylene glycol.

For additional operating instructions, refer to the launcher operator’s manual.

**Figure 7–9—Support the sphere on a wooden block when drilling a hole so antifreeze can be injected.**



**Figure 7–10—Adjusting the PyroShot launcher’s range.**



## Emergency Operating Procedures for Plastic Sphere Launchers

- If an injected sphere becomes lodged in the launcher, the fire may burn itself out. Pour water on the fire to extinguish it. Drop or move away from the launcher if the fire becomes too intense.
- If an injected sphere fails to fall into the chamber of the PyroShot HS, fire will contact the priming bulb and destroy the bulb.

## Maintenance and Storage

Follow these procedures to make sure the slingshots and plastic sphere launchers will be ready the next time they’re needed.

- Unload spheres and glycol from the launcher.
- Return unused spheres and glycol to storage. Do not store spheres and glycol together.
- Inspect the slingshot or launcher for damage. Repair or replace the slingshot or launcher as required.
- Clean and lubricate the launcher following the instructions in the operator’s manual.

## Plastic Sphere Resources

This section includes the following resources:

- Information for inclusion in hazard analyses for slingshots and launchers
- List of required safety data sheets
- Recommended spare parts
- Equipment standards for plastic spheres and launchers
- Contract equipment inspection checklist
- Plastic sphere and launcher references

## Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

Information for Slingshot and Plastic Sphere Launcher Hazard Analyses		
Task	Hazards	Abatement actions
Drilling spheres for injection for use with slingshots	Plastic chips in eyes	Wear eye protection.
	Hand injury	Use a drill press when drilling spheres.
Injecting spheres for use with slingshots	Puncture wounds to hand	Drill the spheres and cover the hole with Cellophane tape to make it easier to inject ethylene glycol and to allow the sphere to vent.
	Sphere bursting in hand	Wear leather gloves.
	Debris in eyes	Wear eye protection.
Handling primed spheres for use with slingshots	Burned hands	Wear leather gloves.  At the first sign of ignition, allow the sphere to fall to the ground and ignite. Allow the sphere to burn out or extinguish it with dirt or water.
Handling a slingshot with a primed sphere	Accidental launch of primed sphere	Keep the slingshot pointed toward the area you want to burn and away from yourself and others.
Loading the launcher magazine	Accidental discharge of launcher	Make sure the launcher is not cocked.
Handling a launcher with a loaded magazine	Accidental discharge of launcher	Make sure the launcher is not cocked until you are ready to launch a sphere.  Keep the launcher pointed toward the area you want to burn and away from yourself and others.
Launching spheres with launchers or slingshots	Primed sphere deflected by obstructions, landing in the launch area	Before beginning the launch sequence, note any obstructions such as tree trunks and limbs. Move to a clear area if necessary. Wear eye protection and a hardhat.
	Hitting someone with a primed sphere	Make sure that everyone is behind you in the launch area. Make sure that no one is near the target area.
	Sphere does not land where intended	Keep the launcher pointed toward the area you want to burn and away from yourself and others. Have handtools and/or water available to extinguish fires.
Handling a launcher if a primed sphere becomes lodged inside	Burned hands	If an injected sphere becomes lodged in the launcher, the fire may burn itself out. Drop the launcher if the fire becomes too intense.

## List of Required Safety Data Sheets

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for plastic spheres and launchers include:

- Ethylene glycol antifreeze
- Potassium permanganate

## Recommended Spare Parts

- Slingshot
  - Rubber bands
  - Syringe and needles
- PyroShot
  - Needles
  - Glycol bottles
  - Piston pin bumpers
- Plastic sphere launcher
  - Needles
  - Specific items listed in the operator's guide

## Equipment Standards for Plastic Spheres and Launchers

### ACCURACY

- Launcher is accurate to within +/- 10 degrees from the point of aim.

### DELAY

- The spheres should not ignite within 20 seconds after being injected with ethylene glycol.

### FUNCTIONING

- The launcher must not damage spheres during feeding.
- The launcher must inject the correct amount of ethylene glycol for proper ignition of the spheres.
- The needle must be the proper size or it may bend when the sphere is injected.
- The needle's design must prevent it from becoming clogged during injection.
- The launcher must not damage spheres during launch.
- The launcher must not leak glycol.
- The launcher must have a failure rate no higher than 1 percent.

### SAFETY

- Must be capable of launching the injected sphere before it ignites.
- Must not pinch fingers during use.
- Injection needle must be located where it cannot puncture fingers or other parts of the body.



### Contract Equipment Inspection Checklist

- Contract plastic spheres and launchers must meet the requirements in this chapter.
- Contract plastic spheres and launchers must be in good operating condition.

### Plastic Sphere and Launcher References

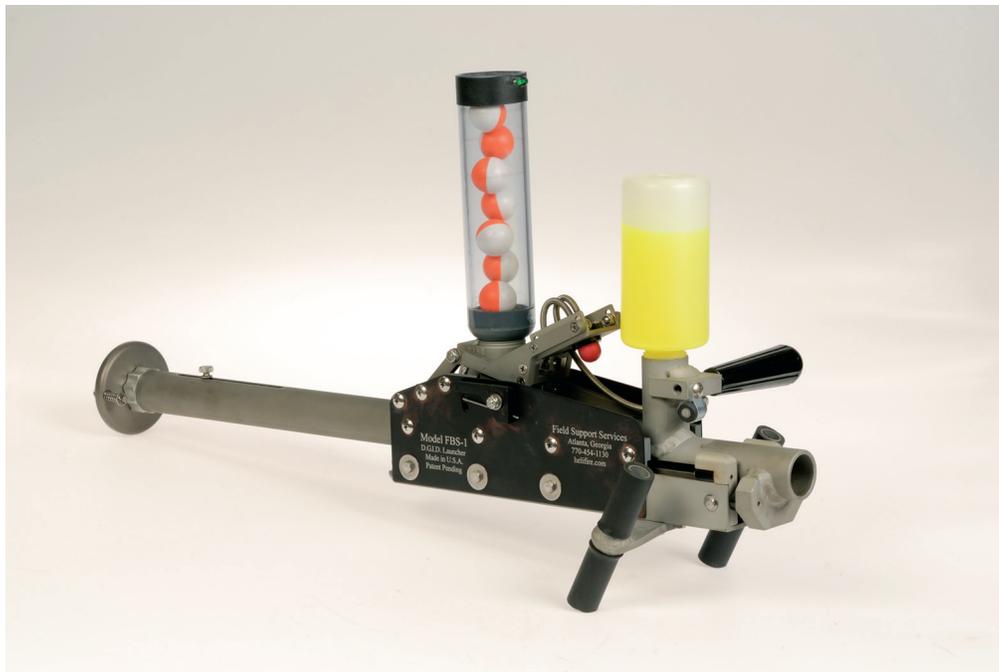
See [appendix B](#) for additional ground ignition references.

PyroShot operator's manuals, available at <http://helifire.com/pyroshot.html>.

*Green Dragon Operations and Service Manual*, available at <http://www.sei-ind.com/>.

*Spitfire Ball-Thrower Operator's Manual*, available from Firecraft Products, Inc. 506-462-7245.

*Everyday HazMat User's Training Guide*, 0471-2810-MTDC, available at [https://www.fs.usda.gov/t-d/everyday\\_hazmat](https://www.fs.usda.gov/t-d/everyday_hazmat).



## Chapter 8—Power Torches

### Equipment Description

Power torches (figure 8–1) are specialized ignition devices that can be used in situations where ATV/UTV torches or terra torches would not be suitable. They often are mounted on a variety of all-terrain vehicles including UTVs, airboats, swamp buggies, and marsh buggies (also known as Marsh Masters). These torches often hold more fuel than a traditional ATV/UTV torch, but less than a terra torch. They usually dispense drip torch fuel instead of the gelled fuel used by a terra torch. Power torches dispense fuel under pressure from a fuel pump through a handheld wand that has an external igniter. Power torches can shoot a stream of burning fuel farther than a traditional ATV/UTV torch but not as far as a terra torch. Power torches encompass a variety of devices that often are built by local fire management units to fill special needs. When used properly, power torches can enhance the safety and efficiency of burn operations in many types of terrain and fuels.

Because most power torches are built locally, they may not be widely commercially available, and may vary in construction, configuration, operating procedures, and mounting options.

**Figure 8–1—This power torch uses the same setup and components as a UTV torch, but the operator uses a handheld wand with an extension hose rather than a mounted wand.**



### Situations Favorable for Power Torch Use

A power torch may work well when:

- Foot travel or ATV/UTV operations are potentially hazardous or impractical, such as when burning marshes and vegetated areas by rock pinnacles or canals.
- You need to carry more fuel (on a vehicle) or when you need to adjust the amount of fuel and the distance it is dispensed.

### Sources of Equipment That Meet Standards

Most power torches are locally procured and must conform to the requirements in the “[Equipment Standards for Power Torches](#)” section at the end of this chapter.

## ADVANTAGES AND DISADVANTAGES

### Using Power Torches

Advantages	Disadvantages
Have a larger fuel tank and can direct burning fuel farther and with greater accuracy than handheld drip torches or ATV/UTV torches	May create more fire than desired
Volume or pressure can be regulated to increase or decrease the distance and the amount of fuel used, allowing a wide variety of ignition tactics	Require careful attention to ignition tactics to prevent increased fire behavior and protect people working near the torch
May be mounted in a variety of different vehicles	
Can be used in areas where foot travel is potentially hazardous or impossible, such as marshes or canals	
Generally don't require as much training and additional support personnel as a terra torch	

## Safety Requirements

Hazard analysis information for use of power torches is provided in the “[Power Torch Resources](#)” section at the end of this chapter. Prepare and review your hazard analysis document before beginning work.

### Required Personal Protective Equipment (PPE)

- Hardhat
- Flame-resistant pants
- Flame-resistant shirt
- Leather gloves
- Approved boots
- Eye protection
- Hearing protection

Additional PPE may be required based on the vehicle carrying the torch. See PPE recommendations in the “[Safety Equipment Summary](#)” table in this chapter.

### MINIMUM SAFETY DEVICES REQUIRED

A dry chemical fire extinguisher (10–B:C minimum) shall be readily accessible, but not attached directly to the torch. The extinguisher's location may vary; but it should be easy to reach. This extinguisher is in addition to any that may be required for the vehicle carrying the torch.

### COMMUNICATIONS

Communications between the power torch operator and support personnel are crucial for safety. Because many specialized vehicles, such as airboats and marsh buggies, are noisy, radio headsets may be needed.

## ADDITIONAL SAFETY CONSIDERATIONS

When a power torch is installed on an airboat or motor vessel, a second vessel (or airboat) is recommended to accompany the ignition vessel in case of equipment failure during burning operations.

If the power torch is installed in an airboat or motor vessel, extra care shall be taken. The combined weight of the fueled torch and operators must not exceed the rated vessel capacity and must not upset the vessel's balance.

Safety Equipment Summary				
Safety consideration	Airboats	Marsh buggies	Rollagons/ Swamp buggies	Aluminum boats
Personal protective equipment (PPE)	Nomex life jackets Standard fireline PPE, helmet recommended to be available but not worn.	Standard fireline PPE	Standard fireline PPE	Nomex life jackets Standard fireline PPE
Communications	Radio headsets	Radio headsets	Radio headsets	Radio headsets
Fire extinguishers	10–B:C minimum (for ignition device)	10–B:C minimum (for ignition device)	10–B:C minimum (for ignition device)	10–B:C minimum (for ignition device)
Other safety considerations	Additional lead airboat Maintain time and distance from flame to avoid pulling the flame into the propeller.	Winch	Winch	Additional lead boat
Equipment operator requirements	Agency-specified training	Agency-specified training	Agency-specified training	Agency-specified training
Weight limits	Within vessel certification	Within vehicle load limits	Within vehicle load limits	Within vessel certification
Mounting requirements	Bolt or affix the torch's skid to the deck of the vessel or vehicle. The unit must be electrically bonded to the vessel or vehicle to prevent static electricity from building up.	Bolt or affix the torch's skid to the deck of the vessel or vehicle. The unit must be electrically bonded to the vessel or vehicle to prevent static electricity from building up.	Bolt or affix the torch's skid to the deck of the vessel or vehicle. The unit must be electrically bonded to the vessel or vehicle to prevent static electricity from building up.	Bolt or affix the torch's skid to the deck of the vessel or vehicle. The unit must be electrically bonded to the vessel or vehicle to prevent static electricity from building up.
Bonding requirements when filling the power torch	Bond the fuel source to the torch, bond the torch, and bond the hose nozzle to the torch.	Bond the fuel source to the torch, bond the torch, and bond the hose nozzle to the torch.	Bond the fuel source to the torch, bond the torch, and bond the hose nozzle to the torch.	Bond the fuel source to the torch, bond the torch, and bond the hose nozzle to the torch.

### Transporting Power Torch Fuel

- Use approved containers (jerricans, safety cans, UN-specification power torches, UN- or DOT-specification fuel tanks).
- Avoid transporting fuel on public highways in power torches that do not meet DOT specifications.
- Make sure that all fuel containers are properly secured when they are being transported.

If you are transporting hazardous materials, a total of no more than 440 pounds of hazardous materials, including power torch fuel in containers smaller than 8 gallons, should be carried in one vehicle.

If more than 440 pounds of power torch fuel or other hazardous materials are transported, or if any fuel container is larger than 8 gallons, DOT hazardous material training and shipping papers are required and a copy of the *Emergency Response Guidebook* must be carried in the vehicle.

If 1,001 pounds or more of a power torch fuel is transported or if any container is larger than 119 gallons, the driver must have a commercial driver's license (CDL) and DOT hazardous materials training. The vehicle must be placarded and must carry shipping papers and a copy of the *Emergency Response Guidebook*.

For more information on transporting fuel, refer to the *NWCG Standards for Transporting Fuel*.

## **Qualifications**

To be qualified to use a power torch for incident or project work, individuals must meet prerequisites and training requirements.

### **Prerequisites**

For torch operators:

- Hold the position of Type 2 firefighter (FFT2) or prescribed fire crewmember (RXCM).
- Demonstrate proficiency with all torch operational and safety procedures.

For firing vehicle operators:

- Demonstrate proficiency operating the firing vehicle in accordance with agency policy, such as policies for boat operators, tracked vehicle operators, and so forth.

For instructors:

- Hold the position of FFT2 or RXCM.
- Demonstrate proficiency with a power torch.

### **Minimum Training**

For torch operators:

- Receive *Ignition Operations* (S-219) training.
- Receive *Intermediate Wildland Fire Behavior* (S-290) training.
- Receive training from a qualified instructor, including an orientation to the power torch and its practical operation in the field.

For firing vehicle operators:

- Become familiar with turning the torch on and off, extinguishing the wick, emergency procedures, and the location and use of the fire extinguisher(s).

### **System Organization and Position Responsibilities**

For power torch operators:

- Operate the power torch.
- Coordinate ignition actions closely with the firing vehicle operator and other fire personnel.
- Be responsible for the preparation, installation, operation, maintenance, care, and cleaning of the power torch.
- In coordination with the firing boss, verify that the desired ignition tactics are being used and are effective. The operators need to adjust ignition patterns as required.
- Recognize malfunctions and act accordingly.

For firing vehicle operators:

- Operate the firing vehicle.
- Coordinate actions closely with the torch operator and additional fire personnel.
- Be responsible for the preparation, operation, maintenance, and care of the vehicle carrying the power torch.
- Ensure that the torch is correctly installed and that the vehicle is within its weight limits and that it is not unbalanced by the weight of the power torch and fuel.

## Inspecting Power Torches

Before power torches are used, the equipment must be inspected and readied for the field.

### Inspections

Inspect the following:

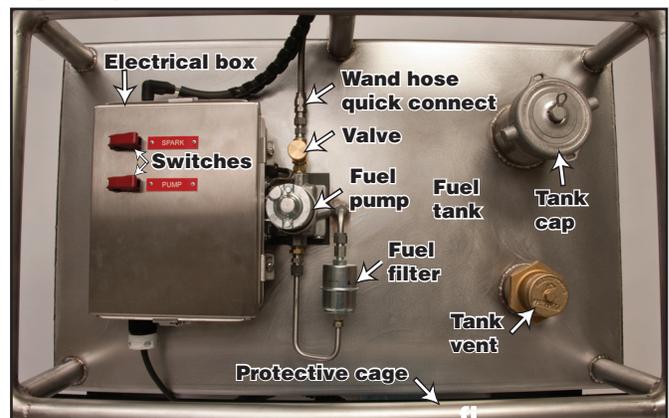
- All electrical connections and wiring.
- All fasteners or straps that attach the torch to the firing vehicle or mounting rack to ensure that they are in place, tight, and in good working order.
- The date when the fire extinguisher was last serviced. Service or replace the fire extinguisher when needed.
- The ignition system to make sure that it is clean and functional (figure 8–2).
- The torch and its quick release mechanism (if it has one) to make sure they are in good working order and that all of their parts are installed properly.
- Caps, seals, and connections for fuel leaks (figure 8–3).

Repair or replace any damaged components.

**Figure 8–2—Power torch wand and hose.** This wand is fitted with the spout from a Panama drip torch. The wand components and braided metal fuel line are compatible with gasoline and diesel.



**Figure 8–3—An example of the components of a power torch.** The spark switch is not needed when a drip torch-style wick ignites the fuel. Specific components vary depending on the model.



## **Firing Vehicle Inspections**

- Use an appropriate inspection checklist, if applicable, for the vehicle carrying the power torch.

## **Preventative Maintenance**

- Follow the land management unit's standard operating procedures (SOPs).

## **Installation Procedures**

- Due to the nature and design of power torches, installation procedures will vary. Both torch mounts and vehicle mounts must be installed in accordance with the manufacturers' instructions, if available. Make sure that the torch is securely fastened to the vehicle. Specifics will be addressed in the unit's SOP for the equipment.

## **Mixing Power Torch Fuel**

When mixing fuel:

- Wear proper PPE.
- Use only approved containers (jerricans, safety cans, and fuel tanks that meet DOT specifications).
- Make sure that the fuel containers are labeled properly.
- Select the proper fuel mixture for the job. Refer to your agency's policy for authorized fuel mixtures. Mixtures other than those authorized by the agency require an additional hazard analysis, such as the Forest Service's job hazard analysis, before the mixtures can be used.
- Containers shall be properly bonded while they are being filled. Ensuring that the fuel nozzle stays in contact with the container is one way to provide bonding.
- Do not fill fuel containers or mix fuel in the bed of a vehicle.
- Mix fuel only in well-ventilated areas.
- Ensure that fuel is thoroughly mixed before using it in a power torch.

## **Normal Operating Procedures for Power Torches**

Follow these procedures when using a power torch.

### **Project Briefing**

- Make sure that a thorough briefing is conducted with all personnel involved with the firing operation before ignition.
- All ignition personnel should:
  - Be familiar with the area proposed for ignition so they understand the location of safe and accessible ignition routes, escape routes, and safety zones.
  - Have a clear understanding of strategy and tactics to be used.
  - Know the ignition pattern(s) before beginning ignition.
  - Know the emergency procedures before beginning ignition.

## Communications

Communications between the power torch operator and the firing boss are crucial to a successful operation. Because power torches are carried by specialized, noisy vehicles, such as airboats and marsh buggies, radio headsets and hand signals may be needed for communication.

## Fueling the Torch

Turn the vehicle engine off.

- Make sure that the torch's wick is completely extinguished and cooled.
- Ensure the tank is properly bonded before filling.
- Do not allow smoking, an open flame, or a heat source within 50 feet while filling the power torch.
- Avoid spilling fuel.
- Do not completely fill the torch's tank—fill it only to about 90 percent of its capacity before replacing the cap. Overfilling may cause pressure to build in the torch's tank, forcing fuel out of the wand.
- Clean up any spills during fueling.

## Using the Torch

- Remember that the wind can blow burning fuel from the wick toward the firing vehicle.
- Adjust ignition patterns as the ignition progresses or as the fire behavior changes.
- Be aware of fuels, terrain, and ignition tactics because they affect fire behavior, escape routes, and safety zones.
- Stay within the burn unit while lighting the wick.
- Maintain communications with all firefighters at the site while firing.
- Remember—torches can put a lot of fire on the ground in a short time (figure 8–4).
- Watch out for obstacles in the vehicle's path to avoid getting the vehicle stuck or damaging it.
- Be aware of barriers such as ditches, dense vegetation, or large canals that could block escape routes.

Figure 8–4—A power torch at work.





## Emergency Operating Procedures for Power Torches

The firing vehicle and its torch are not worth injury or risk of life. Get away from the firing vehicle if it becomes a hazard.

In the event of an emergency, the torch operator needs to tell the firing vehicle operator there is a problem and give a brief description of the emergency.

Power torch operators need to know what to do in the following situations:

- Torch or vehicle catches fire
  - If the torch or firing vehicle catches fire, attempt to extinguish the fire in its initial stage.
  - If the fire is persistent, remove the torch from the firing vehicle, if possible.
  - If the torch cannot be removed, leave the firing vehicle and go to a safe area. Notify the appropriate personnel.

## Maintenance and Storage

Follow these procedures to make sure that power torches will be ready for their next use.

### Cleaning and Repair

- Clean the torch and inspect it for damage.
- Repair or replace any damaged or broken parts.

### Storing the Torch

- Drain the fuel to the lowest practical level.
- Store the torch out of the weather in a secure location.

### Storing Power Torch Fuel

- Store the torch fuel according to agency policy.
- For further guidance on torch and fuel storage, consult your local hazardous materials coordinator and the *Everyday HazMat User's Training Guide*.

### TROUBLESHOOTING

#### Torch Does Not Dispense Fuel

- Check the electrical system—it may be disconnected.
- Make sure the wiring is intact and not damaged or broken.
- Make sure the fuse is not blown.
- Make sure the pump is not defective.
- Make sure the tank vent is open and clear.
- Make sure that the hoses, piping, and tubing are unobstructed.

#### Torch Goes Out

- Check the fuel mixture—it may have too much diesel.
- Make sure the wick or propane torch is adjusted properly.
- Make sure the propane bottle has fuel (propane ignition systems only).

#### Fuel Burns Up Before Reaching Vegetation

- Check the fuel mixture—it may have too much gasoline.

## Power Torch Resources

This section includes the following resources:

- Information for inclusion in a hazard analysis
- List of required safety data sheets
- Recommended spare parts
- Equipment standards for power torches
- Contract equipment inspection checklist
- Power torch references

## Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

Information for Power Torch Hazard Analyses		
Task	Hazards	Abatement actions
Fueling or refueling the torch	Fuel spills Breathing fuel vapors Fuel spilled on skin Burns Lifting heavy loads	Wear PPE. Have a spill kit available. Keep ignition sources at least 50 feet away from the refueling area. Use safety cans with proper spouts. Know the proper fuel mixture. Check for fuel leaks. Avoid breathing fumes. Use proper lifting techniques.
Igniting the torch	Burns Fumes and smoke	Wear PPE. Keep the wand pointed away from all personnel and equipment. Use the proper methods when igniting the torch. Avoid breathing fumes.
Burning operations	Burns Fumes and smoke	Wear PPE. Keep the wand pointed away from all personnel and equipment. Know the ignition sequence before starting. Always have a way out. Watch your speed and obstacles. Avoid breathing fumes. Maintain lookouts, communications, escape routes, and safety zones (LCES). Be aware of where the fire is burning, where you are driving, and which way the wind is blowing.
Extinguishing the torch	Burns Fumes and smoke	Wear PPE. Use proper techniques when extinguishing the torch. Avoid breathing fumes.
Operating the firing vehicle	Hazardous when not operated properly	Only qualified firing vehicle operators with knowledge of torch and ignition operations are allowed to drive firing vehicles.

### **List of Required Safety Data Sheets**

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for power torches include:

- Diesel
- Gasoline
- Propane

### **Recommended Spare Parts**

- Fuel pump
- Fuel filters
- Fuel line assemblies
- Fuses
- Electrical tape
- Extra wiring
- Extra wicks
- Extra wand
- Fuel caps
- Pressure relief valve (if equipped)

### **Equipment Standards for Power Torches**

All components must be compatible with diesel and gasoline.

#### **FUEL TANK**

- Tank capacity varies, but the weight when filled must not exceed the load rating of the firing vehicle.
- Baffles are recommended inside the tank.
- Tanks must be made of metal—welded aluminum has been the preferred material.
- Tanks must be vented to prevent pressure from building up and to allow the fuel pump to operate properly.
  - Tanks with more than 60 gallons capacity must be designed to be filled from the bottom.
  - Tanks smaller than 55 gallons do not need to conform to DOT specifications, but only if a DOT-specification tank cannot be found.
  - Tanks 55 gallons or larger must meet DOT specifications.
- The fuel pump must be originally designed for gasoline and diesel use.

#### **TORCH ARM OR WAND**

- Construction varies, but the arm or wand must include an on/off valve or trigger.
- Power torches may use a wand similar to a terra torch or an arm similar to an ATV/UTV torch.
- The arm or wand must have flashback protection (such as a fuel trap or a check valve).

#### **IGNITION SYSTEM**

- A conventional drip torch nozzle and wick may be used. Some power torches may use a propane ignition system.

#### **HOSES/FUEL LINES**

- Metal pipe or tubing may be used.
- Hoses must be compatible with diesel and gasoline and have a metal braided cover.
- Hoses must use swaged end connections; hose clamps shall not be used.
- If the fuel pump or wand is gravity fed, a manually operated shutoff valve must be installed upstream of the pump on the tank or the fuel line and the valve must be protected so it cannot be torn loose during operation. Pumps that draw fuel from the top of the tank do not require a tank shutoff valve.

#### **ELECTRICAL SYSTEM**

- Wiring must be free of splices.
- All wiring must be housed in abrasion-resistant covering.
- All electrical connections must be sealed with RTV (room temperature vulcanizing silicone rubber) to prevent sparking, except for the quick disconnect that allows the torch to be removed from the vehicle that carries it.
- An inline fuse must be installed as close to the power source as possible.
- The minimum fuse size is determined by multiplying the total electrical load required by all of the torch's electrical equipment by 1.5.
- A pump shutoff switch shall be located within easy sight and reach of the torch operator.
- Solenoid valves (if used) must have explosion-proof solenoids.
- The torch must be properly bonded to the mounting vehicle.

The tank and the torch should be mounted on a single base that is securely attached to the firing vehicle. This mounting should be designed to ensure that the vehicle's balance is maintained.

## Contract Equipment Inspection Checklist

- Metal fuel tanks are required.
- The weight of the torch and full fuel tank do not exceed the load rating of the vehicle that carries them.
- The fuel tank is vented to prevent pressure from building up and to allow the fuel pump to operate properly.
- The fuel pump was originally designed for use with gasoline and diesel.
- The arm or wand has an on/off valve or trigger.
- If the fuel pump or wand is gravity fed, a manually operated shutoff valve is installed upstream of the pump on the tank or the fuel line and the valve is protected so it cannot be torn loose during operation. Pumps that draw fuel from the top of the tank do not require a tank shutoff valve.
- All components are compatible with diesel and gasoline.
- All hoses have a braided metal cover and swaged end fittings.
- The wiring is free of splices.
- An inline fuse is installed as close to the power source as possible.
- The fuse size is at least 1.5 times the total electrical load required by all torch equipment.
- All wiring has an abrasion-resistant covering for protection.
- All electrical connections except the quick disconnect used to remove the torch from the firing vehicle are sealed with RTV silicone rubber to prevent sparks.
- Solenoid valves (if used) have explosion-proof solenoids.
- The torch's electrical controls are within easy sight and reach of the operator.
- The torch is mounted on a single base that is securely attached to the firing vehicle.

## Power Torch References

See [appendix B](#) for additional ground ignition references.

*NWCG Standards for Transporting Fuel*, PMS 442, available at <http://www.nwcg.gov/publications/442>.

*Everyday HazMat User's Training Guide*, 0471–2810–MTDC, available at [https://www.fs.usda.gov/t-d/everyday\\_hazmat](https://www.fs.usda.gov/t-d/everyday_hazmat).



## Chapter 9—Propane Torches

### Equipment Description

A typical propane torch that can be used as a ground ignition device consists of a torch assembly, a propane cylinder, a hose, and a regulator or flame adjustment valve. Most torches use propane vapor as the fuel, although some are designed to use liquid propane.

### Sources of Equipment That Meet Standards

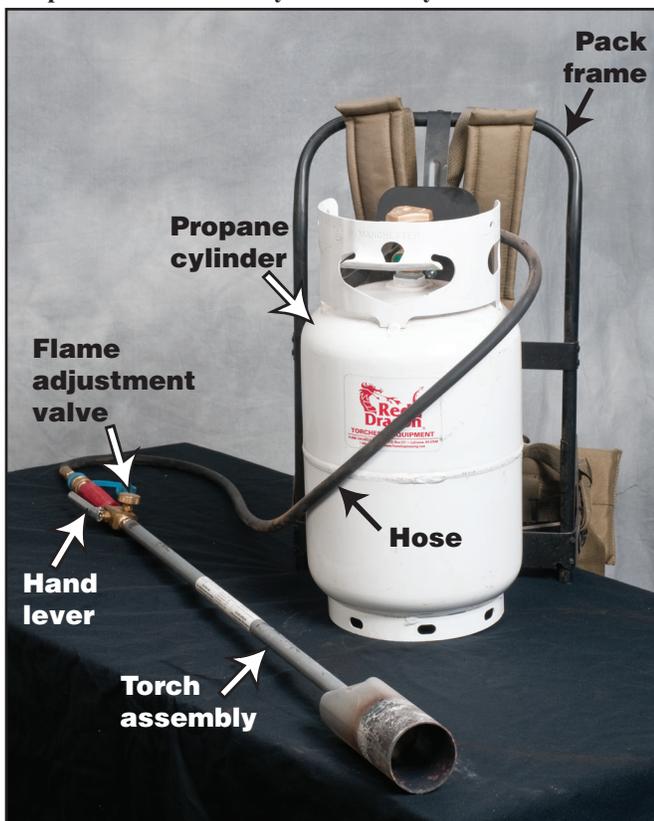
Propane torches, commonly used for weed burning, may be found at hardware and ranch supply stores.

### Situations Favorable for Propane Torch Use

A propane torch (figure 9–1) may work well when:

- Burning grass, pine needles, leaves, brush, and similar fine fuels that ignite readily.
- Burning in areas where fuel residue from other ignition devices, such as drip torches and fuses, may be an issue.

Figure 9–1—A propane torch equipped with a pack frame. Propane torches also may be carried by hand.



## Safety Requirements

Hazard analysis information for propane torch operations is provided in the “Propane Torch Resources” section at the end of this chapter. Prepare and review your hazard analysis document before beginning work.

### ADVANTAGES AND DISADVANTAGES

#### Using Propane Torches

Advantages	Disadvantages
Readily available from several commercial sources	Not as portable as other ignition devices and can be cumbersome to carry
Leave no fuel residue	Not as effective (as other ignition devices) for burning heavier fuels
	Performance of the torch declines as temperature falls
	Propane fuel requires special hazardous materials consideration for transportation and storage

#### Required Personal Protective Equipment (PPE)

- Hardhat
- Flame-resistant pants
- Flame-resistant shirt
- Leather gloves
- Approved boots
- Eye protection

#### Transporting Propane Cylinders

- Secure all propane cylinders before transport. Secure all items in the vehicle cargo compartment so that loose items cannot damage the cylinders when the vehicle is moving.
- Do not transport propane cylinders with explosives, poisonous gases, poisonous or corrosive liquids, or radioactive materials.
- Do not transport damaged cylinders.
- Transport propane cylinders in aircraft in accordance with chapter 6 of the *NWCG Standards for Aviation Transport of Hazardous Materials*, PMS 513.

According to the DOT, propane fuel is a Class 2, Division 2.1 flammable gas. This means that you should not transport more than 440 pounds of hazardous materials, including propane, in one vehicle. The propane should be transported in cylinders with a gross weight of no more than 220 pounds.

If you are transporting more than 440 pounds of propane, other hazardous materials, or the propane cylinders weigh more than 220 pounds gross weight, DOT hazardous materials training is required and you must carry shipping papers and a copy of the *Emergency Response Guidebook* in the vehicle.

If you are transporting 1,001 pounds or more of propane or other hazardous materials, you must have a commercial driver's license (CDL) with a hazardous materials endorsement in addition to DOT hazardous materials training. You must carry shipping papers and a copy of the *Emergency Response Guidebook* in the vehicle, and the vehicle must be placarded.

## **Qualifications**

To be qualified to use a propane torch for incidents or projects, individuals must meet prerequisites and training requirements.

### **Prerequisites**

For operators:

- Hold the position of Type 2 firefighter (FFT2) or prescribed fire crewmember (RXCM).

For instructors:

- Hold the position of FFT2 or RXCM.
- Demonstrate proficiency with a propane torch.

### **Minimum Training**

For operators:

- Read and understand the information in this chapter.
- Read the operator's manual or instructions for the specific model of propane torch.
- Receive training in operation and maintenance of propane torches from an instructor.

For instructors:

- Demonstrate proficiency with a propane torch.



## Inspecting Propane Torches

Before propane torches are used, the equipment must be inspected and readied for the field.

### Inspections

Inspect the following:

- Cylinder for dents.
- Protective collar for damage (figure 9–2). Do not use cylinders without a protective collar.
- Foot ring for rust (figure 9–3).
- Hoses, regulators, valves, gauges, and fittings for damage, wear, and leakage. Use soapy water to check for leaks; never use a match or open flame.

Repair or replace equipment that is damaged or that leaks. Verify that the propane cylinders have enough propane to complete burning operations.

Figure 9–2—Top view of a propane tank.

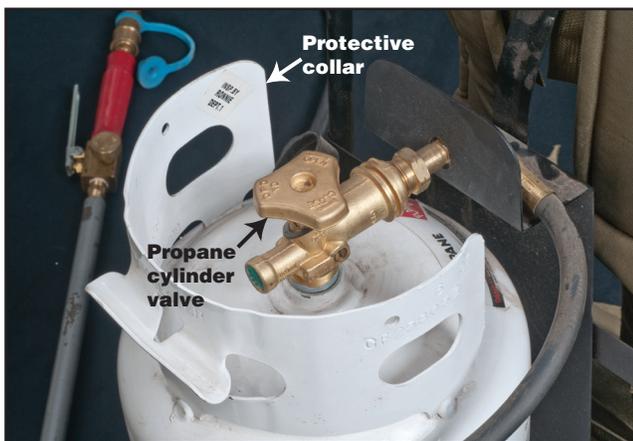


Figure 9–3—Bottom view of a propane tank attached to a pack frame.



## Normal Operating Procedures for Propane Torches

Follow these procedures when using a propane torch.

### Preparing the Torch for Use

- The operator must wear the proper PPE.
- Use the proper cylinder for your torch. Some torches burn propane vapor. Others burn liquid propane.
- Always read and follow the manufacturer's warnings, precautions, and safety instructions.
- Use soapy water to check for leaks. Never use a match or open flame.
- Do not use the torch if you can smell propane.
- Never carry a propane cylinder by the valve.
- Do not ignite the torch before you have reached the area you want to burn.
- Open the cylinder valve when you are ready to ignite the torch.

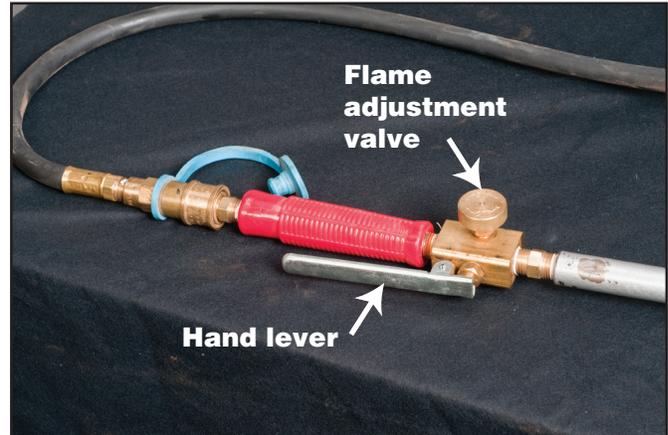
## Igniting the Torch

- Light the torch using an igniter that keeps your hand well away from the flame. Do not use matches or a cigarette lighter (figure 9-4).
- Make sure that the flame adjustment valve or regulator is operating in accordance with the manufacturer's instructions (figure 9-5).

Figure 9-4—A small hand torch can be used to ignite a propane torch.



Figure 9-5—A flame adjustment valve with a hand lever. After the valve has been set, the hand lever is used to adjust the flow of the propane.



## Using the Torch

- Point the burning torch away from yourself, other objects, and people.
- Keep the torch, open flame, and other sources of ignition away from the propane cylinder, the hose, and the regulator.
- Be aware that much of a propane flame is not readily visible and extends a substantial distance beyond the visible portion.
- Do not heat the propane cylinder to increase its pressure.
- Never leave a burning torch unattended.
- Keep the propane cylinder's valve closed when the torch is not being used.

## TROUBLESHOOTING

### Torch Will Not Light

Make sure the gas cylinder's valve is open and unobstructed.

Check to see whether the gas cylinder is empty.

Make sure the regulator is functioning normally.

### Torch Assembly Leaks Gas

Make sure the connections are tight.

Check the propane hose for damage.

### Extinguishing the Torch

- Extinguish the torch by shutting off the cylinder's valve and allowing gas to burn out of the lines.

### Preparing the Torch for Transportation and Storage

- Allow the torch to cool before transporting or storing it.
- Always secure propane cylinders so they are level and upright while transporting them in vehicles or on watercraft. Do not lay cylinders on their side or store them upside down. Because propane vapors are heavier than air, they can accumulate in low areas such as truck beds and boat hulls. The vapors can catch fire and could displace oxygen in enclosed areas, causing burns or suffocation.

### Emergency Operating Procedures for Propane Torches

Propane torch operators need to know what to do in the following situations:

- Smell of propane detected during use.
  - Stop using the torch immediately.
  - Move the torch away from any sources of ignition.
  - Close the propane cylinder's valve.
  - Repair or replace the equipment.
- Torch assembly or propane cylinder catches fire.
  - Drop the equipment and leave the area immediately.

### Maintenance and Storage

Follow these procedures to make sure that propane torches will be ready for their next use.

#### Cleaning and Repair

- Disconnect the torch assembly from the cylinder.
- Inspect the torch assembly and cylinder for damage.
- Repair any damaged equipment.

## Storing Propane Cylinders

- Store propane cylinders outside in a controlled access area.
  - Store propane cylinders upright unless the cylinders are designed to operate while horizontal.
  - Store propane cylinders at least 20 feet away from flammable liquids such as gasoline and drip torch fuel, flammable solids such as fuses, and oxidizing gases such as oxygen.
  - Store the torch assembly (disconnected from the propane cylinder) in a dry location out of the sunlight.

For further guidance on storing propane cylinders and torch assemblies, consult your local hazardous materials coordinator and the *Everyday HazMat User's Training Guide*.

## Propane Torch Resources

This section includes the following resources:

- Information for inclusion in a hazard analysis
- List of required safety data sheets
- Equipment standards for propane torches
- Propane torch references

## Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

Information for Propane Torch Hazard Analyses		
Task	Hazards	Abatement actions
Checking the torch for leaks	Burns	Use soapy water to check for leaks. Do not use matches or other open flame.
Igniting the torch	Burns	Wear gloves, flame-resistant clothing, boots, a hardhat, and eye protection. Point the torch away from your body and other people and objects when you are lighting it. Use an igniting device or method that allows the torch to be ignited while your hand is far away.
Using the torch	Burns	Wear gloves, flame-resistant clothing, boots, a hardhat, and eye protection. Point the torch away from your body and other people and objects. If you smell propane, stop using the torch immediately. Repair or replace the torch.
Using the torch	Muscle strain	Use a cart or other device to carry the cylinder if practical. Use the smallest cylinder that will do the job. Set the cylinder down often. Watch your footing while carrying the torch.

### List of Required Safety Data Sheets

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for propane torches include:

- Propane

### Equipment Standards for Propane Torches

Equipment must be listed by a nationally recognized testing laboratory, such as Underwriters Laboratories (UL) or Canadian Standards Association (CSA).

### Propane Torch References

See [appendix B](#) for additional ground ignition references.

*Everyday HazMat User's Training Guide*, 0471–2810–MTDC, available at [https://www.fs.usda.gov/t-d/everyday\\_hazmat](https://www.fs.usda.gov/t-d/everyday_hazmat).



## Chapter 10—Terra Torches

### Equipment Description

The terra torch is a ground ignition device that dispenses ignited gelled fuel for firing operations (figure 10–1). Gelled fuel is a combination of a gelling agent and petroleum fuels such as gasoline, diesel fuel, or aviation fuel. One advantage of gelled fuel is that it is less volatile than ungelled fuels. The fuel is gelled in the terra torch tank and pumped from the tank through a wand equipped with a propane torch igniter. The ignited gelled fuel can be propelled 50 to 100 feet from the wand, depending on gel consistency, wind direction, and windspeed. In 2003, specifications were imposed that required standard safety features for all terra torches and batch mixers. The new torches typically include U.S. Department of Transportation (DOT)-specification tanks, rollover protection, and safety valves. Be aware that additional agency-specific requirements may be in place.

Figure 10–1—A terra torch in action.



### Sources of Equipment That Meet Standards

Each terra torch manufacturer shall provide an operations manual specific to their terra torch. Each manual will be reviewed and accepted by the Ground Ignition Subcommittee.

#### Terra Torches

##### MANUFACTURER

GelFire Systems (formerly Firecon, Inc.)  
P.O. Box 307  
Ontario, OR 97914  
Phone: 541–889–8630

##### FIRECON PRODUCTS

- 2400 Batch Mixer System
- Terra Torch Model 1400

##### FIRECON NONSPECIFICATION PRODUCT

- 40- or 50-gallon minitorch

**GELFIRE SYSTEMS PRODUCTS**

- GFS 50 Terra Torch
- GFS 100 Terra Torch
- Firecon 140 (upgraded Firecon Terra Torch Model 1400)
- Mini 40- or 50-gallon Terra Torch (upgraded Firecon 40- or 50-gallon minitorch)

**Note:** Upgrading Firecon products is suggested.

**AGENCY PRODUCTS**

- 110-Gallon Terra Torch
  - Obtain information from:  
 Ignition Specialist  
 Forest Service—NTDP  
 5785 Highway 10 West  
 Missoula, MT 59808-9361  
 Phone: 406-329-3900

**ADVANTAGES AND DISADVANTAGES**

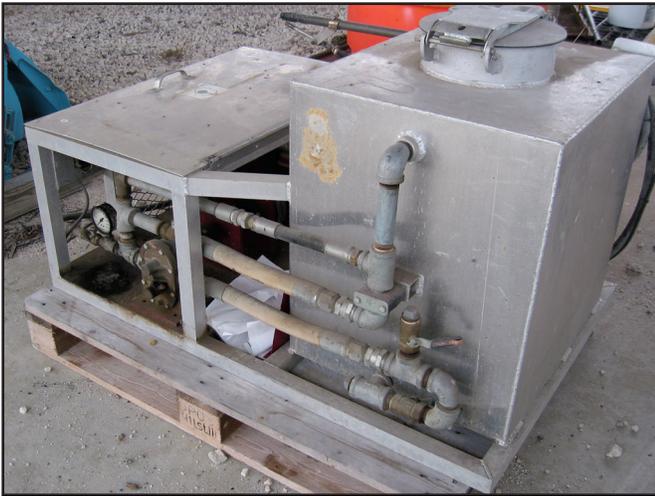
**Using Terra Torches**

<b>Advantages</b>	<b>Disadvantages</b>
Increase the safety of firing operations by reducing firefighter exposure because fewer people are required	Required specialized training for crews
Enhance employee safety by allowing ignition of otherwise inaccessible areas (vegetation on the other side of water or other barriers, steep slopes, or thick vegetation)	Produce immediate, intense fire; care must be taken not to ignite a larger area than the situation warrants
Produce an intense, continuous line of fire that can achieve better consumption of the vegetation than other ignition systems	May cause additional hazards because ungelled gasoline is highly flammable
Develop a convective column quicker, increasing control over the fire, and reducing smoke management issues	May have to haul bulk fuel and gelling agent to the site for larger burning operations
Can ignite a burn unit in less time than hand ignition, taking advantage of narrow burn windows	Increase the need for adequate hazmat removal and storage
More effective than other ignition systems for burning under a wide variety of fuel conditions and fuel types	Require the vehicle operator to have a CDL with a hazmat endorsement when transporting tanks larger than 119 gallons
Can be mounted on a variety of vehicles including trucks, trailers, boats, air boats, utility-terrain vehicles (UTV), and marsh buggies (also known as Marsh Masters)	Increase hazards to the ignition crew from the splatter of the burning gel
Gelled fuel provides a longer residual burning time on the vegetation	May require dedicated resources (additional crewmembers or an engine) that may not be needed with other ignition methods
	Increase risk of unwanted fire, operator injury, or vehicle damage caused by burning gel dripping from the wand

The Firecon 40- or 50-gallon minitorch (figure 10–2) was developed for applications where a full-sized terra torch was not practical, such as in airboats. The minitorch is not equipped with a DOT-specification tank. These minitorches can be used under the following conditions:

- The torch is in good mechanical condition.
- With the exception of the DOT-specification tank, the torch conforms to the requirements in the “[Terra Torch Resources](#)” section at the end of this chapter.
- The fuel tank is given a careful visual external inspection for leakage before each use. A torch with a leaking tank shall not be used.
- The torch is transported empty to and from the burn site. A torch is considered to be empty when the tank has been drained as low as practical, even if some residual fuel remains.
- All of the applicable parts of this guide are followed when using the minitorch.
- The torch will be stored empty. The torch is considered to be empty when the tank has been drained as low as practical, even if some residual fuel remains.

**Figure 10–2—An example of a 40-gallon minitorch.**



## **Gelling Agents**

### **DISTRIBUTOR**

Type One Incident Support, Inc.—Flash 21  
P.O. Box 8209  
Bend, OR 97708–8209  
Phone: 541–330–4340



## Situations Favorable for Terra Torch Operations

A terra torch may work well when:

- Burn units with continuous vegetation are immediately adjacent to vehicle access.
- Sites have sparse or patchy fuel distribution or high fuel moisture content. The intensity of the fire produced by the torch can provide sustained ignition and, under some conditions, reduce emissions.
- Ignition of fuels requires a concentrated, intense fire, such as standing timber, blowdown, or poorly compacted fuels.
- Burning areas where a quickly established convection column is desired.

## Safety Requirements

Hazard analysis information for terra torch operations is provided in the “[Terra Torch Resources](#)” section at the end of this chapter. Prepare and review your hazard analysis document before beginning work.

### Required Personal Protective Equipment (PPE)

Wear the PPE described below for mixing and burning operations.

- Mixing operations using powdered or liquid gelling agents
  - Nomex III-A clothing, Nomex clothing containing 2 percent carbon core or 3 percent conductive fiber (listed on the clothing label), cotton clothing (including underwear)
  - Chemical resistant (Nitrile) gloves
  - Goggles
  - Approved boots
  - Hardhat
  - Mixing personnel may wear a dust mask. See the “[Terra Torch Resources](#)” section at the end of this chapter for dust mask use and storage requirements.
- Burning Operations
  - Approved fireline PPE according to *Interagency Standards for Fire and Fire Aviation Operations* (chapter 7), including eye protection, shall be worn during burning operations.

### Minimum Safety Equipment Required

#### MIXING OPERATIONS

- Two 20–B:C dry chemical fire extinguishers
- One burn kit
- One burn blanket

One portable eye wash station (minimum 15-minute continuous flow)

#### BURNING OPERATIONS

- Two 20–B:C dry chemical extinguishers
- One burn kit
- One burn blanket

#### Caution

A portable eyewash station is required onsite. OSHA 1910.151 and 1926.50 requires that when the eyes may be exposed to injurious corrosive materials, suitable facilities for the quick drenching or flushing of the eyes shall be provided for immediate emergency use—**MINIMUM 15-MINUTE CONTINUOUS FLOW**. The American National Standards Institute (ANSI) outlines what OSHA considers suitable facilities in ANSI Z358.1

## Transporting the Gelling Agent and Fuel

- Transport bulk fuel whenever possible using a fuel truck with its own pumping system.
- Load and transfer all fuels in an area isolated from traffic to reduce unnecessary risk. In the field, the fueling area should be a clear, flat area at least 50 feet in diameter.

Use a portable refueling system when it is not possible to transport bulk fuel.

## HANDLING THE GELLING AGENT AND FUEL

- Powdered gelling agents must be kept dry. Fire-Trol Firegel is nontoxic and can be disposed of in a landfill; no spillage should remain on the site after the operation is completed.
- Keep your entire operation clean and tidy. This includes the fueling and mixing sites, the vehicle, and the terra torch unit. Wipe up all minor spills immediately.

## Qualifications

To be qualified to use a terra torch for incident or project work, individuals must meet prerequisites and training requirements.

### Prerequisites

For operators:

- Hold the position of Firefighter Type 2 (FFT2) or prescribed fire crewmember (RXCM).
- Hold the position of terra torch operator (TTOP).

For lead operators and instructors:

- Hold the position of Firefighter Type 1 (FFT1).
- Hold the position of terra torch operator (TTOP).
- Receive *Firing Operations* (S-219) training.
- Receive agency certification.

Operators, lead operators, and instructors should receive training documentation to verify their level of completed training and experience.

### Minimum Training

For operators:

- Receive operational training in accordance with unit-specific terra torch equipment and procedures. Training subject matter shall include:
  - Safety
  - Operation
  - Maintenance and troubleshooting
  - Cleaning the terra torch after use
  - Transportation
  - Storage

For instructors:

- Receive operational training and demonstrate proficiency with a terra torch.

## System Organization and Position Responsibilities

The recommended organization for terra torch operations consists of a terra torch lead operator, terra torch operator, and vehicle operator. For some burning operations, such as pile burning and air boat operations, only the vehicle operator and the lead terra torch operator positions may be required.

### TERRA TORCH LEAD OPERATOR

- Oversees safe operation of the terra torch.
- Coordinates ignition actions closely with the vehicle operator and additional fire personnel.
- Maintains situational awareness.
- Ensures proper preparation, installation, operation, and maintenance of the terra torch.
- In coordination with the firing boss, verifies that desired ignition tactics are being used and are effective. Adjusts ignition patterns as required.
- Determines whether malfunctions have occurred and acts accordingly.

### TERRA TORCH OPERATOR

- Operates the terra torch.
- Prepares, installs, operates, and maintains the terra torch.

### VEHICLE OPERATOR

- Operates the ignition vehicle.
- Coordinates actions closely with the terra torch lead operator and additional fire personnel.
- Maintains situational awareness.
- Ensures proper preparation, installation, operation, maintenance, and care of the ignition vehicle.
- Ensures the proper weight and balance of the vehicle is maintained.

## Inspecting Terra Torches and Mixing Fuel

Before terra torches are used, the equipment must be inspected and readied for the field.

### Inspections

The inspector shall:

- Verify that all tank inspections are up to date. For more information, refer to the *NWCG Standards for Transporting Fuel*.
- Verify that the tank is properly placarded and marked.
- Check the engine oil level before operation. Add oil if needed.
- Check the tension on the belts and adjust if needed (figure 10–3).
- Check all fasteners for tightness. Tighten any loose fasteners.
- Check the hose fittings and general integrity of the unit.
- Make sure that all seals are in place and in good condition.
- Inspect the tank, plumbing, pump, hoses, valves, and applicator wand for leaks. Correct any leakage before use.
- Verify the electrical continuity of the vapor recovery/removal hose between the end fittings and bonding cables.

**Figure 10–3—Inspect the pump drive belts (if present) for damage and wear. Adjust the tension as needed.**



### **Mixing Terra Torch Fuel**

When mixing fuel, personnel must understand the hazards of terra torch operations and know the precautions they should take. Mixing should take place only after all personnel involved are adequately trained and equipped.

#### **Precautions**

Hazards to the mixing personnel include vapors from gasoline, flammability of gasoline, skin and eye contact with fuel, and dust from the gelling agent. Review the “[Terra Torch Resources](#)” section at the end of this chapter and the links to the safety data sheets in [appendix A](#).

- Avoid prolonged and direct exposure to gasoline vapors. They depress the nervous system and are known carcinogens.
- Make sure personnel keep their hands out of gasoline and fuel mixtures. Special care must be taken to keep fuel from the mouth, eyes, open cuts, and abrasions.
- Make sure only trained personnel will handle and mix fuel (according to agency or bureau policies).
- Set up the mixing areas with special attention to the safety equipment available and the training of the mixing crew.
- **Remember, nonferrous mixing equipment must be used (to prevent sparks) and all bonding procedures must be followed.**
- Make sure that precautions are exercised to eliminate direct skin or eye contact with gelling agent or fuel.
- Make sure NO SMOKING signs are conspicuously posted around the mixing area, including near the outlets of all vapor removal hoses.

### Caution

No plastic of any kind shall be used in mixing operations when powdered gelling agent is used. All dispensing equipment must be made of metal capable of being bonded—no plastic components. Do not pour gelling agent directly from the bag into the drum/tank (NFPA 77).

All handheld electronic devices such as radios, pagers, cell phones, and so forth shall be turned off within 50 feet of any fuel preparation/vapor removal area.

### Caution

Do not use biodiesel or fuels oxygenated with ethanol. These fuels will not gel.

## Fuels

The following fuels or combinations of the following fuels may be used with Flash 21 gelling agent to make gelled fuel:

- Gasoline
- Avgas
- Gasoline or Avgas/JP8 (50:50)
- Gasoline or Avgas/Diesel (50:50)
- Gasoline or Avgas/Jet A (50:50)

The above ratios are recommended starting points when using Flash 21 gelling agent and may be adjusted as required to achieve the desired consistency. Other gelling agents may require different mix ratios. An ideal gelled mix creates a flame that appears at the top of the arc when shooting gel. Flames appearing closer to the wand result in less gelled fuel on target.

### Fire Protection

Designate a “fire protection” person during fueling operations and make sure this person has ready access to a 20–B:C fire extinguisher. This individual will wear appropriate PPE for fire suppression and will be responsible for properly charging extinguishers before fueling.

Provide additional care and security when fueling at public service stations.

## Fueling From Bulk Fuel Supply

- Verify the electrical continuity of the fuel supply hose and bonding cables.
- Make a bonding connection to prevent static electricity from building up during fueling operations. Pull out retractable bonding wire from the bonding reel of the terra torch. Attach the bonding wire to the fuel source, using an alligator jaw grip clamp at the end of the wire.
- Remove the camlock cover from the vapor recovery shutoff valve. Remove the camlock covers from the vapor recovery hose. Attach the vapor recovery hose to the camlock vapor recovery fitting at the top of the tank. Open the vapor recovery shutoff valve.
- Make sure the tank is clean.
- Dispense the desired quantity of fuel in the fuel port (figure 10–4).

Figure 10–4—Fill the terra torch through the fuel port, not through the tank hatch cover, to avoid generating static electricity that could ignite fuel vapors.



## Gelling Agents

### FIREGEL (ALSO KNOWN AS SUREFIRE)

Firegel is a powdered gelling agent designed to thicken fuels used in prescribed burning.

- Formulated to be used at 3 to 5 pounds to 54 gallons of fuel.
- Mixes with various fuels including straight gas, Jet B, diesel, or a gas/diesel mix. For best results, straight gas is preferred.
- **Firegel is in the process of being phased out and replaced with Flash 21 by most operators.**

### *Mixing Procedures for Firegel*

- Break up clumps of Firegel before mixing.
- Make sure that the mixing tank is clean.
- Add 15 to 20 gallons of fuel.
- Start the engine and recirculate the fuel. Make sure that all tank valves are open, the recirculation valve is open, and the recirculation switch is on.
- Add Firegel very slowly to the fuel. The amount of Firegel required will depend on the type of fuel, the fuel's temperature, and thickness of the gel desired. For cooler fuels (such as 30 to 40 °F or colder) add  $\frac{1}{3}$  to  $\frac{1}{2}$  more Firegel to ensure complete gelling. Warm fuels (60 to 70 °F) require less Firegel and will set up quickly.
- Add the remainder of fuel while recirculating.
- Continue to recirculate for about 5 to 10 minutes after all fuel has been added and the Firegel is dissolved. Recirculate periodically.
- Close the mixing tank and allow the gel to set up.
- Check the thickness. The gel should be the consistency of “applesauce.” General rules of thumb for mixing: The colder the temperature, the longer the mix will need to set for proper consistency. **Gelling powder cannot be added once the mixture has begun to set up.**

## PETROL JEL

- Petrol Jel is a liquid gelling agent designed to thicken fuels used in prescribed burning.
- Specifically formulated for one 4-litre container to be used with 54 gallons of fuel. Settling of the product in the container is normal.
- Sets up quickly, especially in warm fuels, but may take up to 30 minutes in cold fuels. Under normal conditions, there is no need to mix Petrol Jel until the burn operation is confirmed.
- Known to break down (thin) quickly.
- Can be mixed with various fuels including straight gas, Jet B, diesel, or a gas/diesel mix. For best results, straight gas is preferred.
- **Petrol Jel is in the process of being phased out and replaced with Flash 21 by most operators.**

### *Mixing Procedures for Petrol Jel*

- Agitate the Petrol Jel container until the powder is completely suspended in the liquid.
- Make sure that the mixing tank is clean.
- Fill the mixing tank with fuel.
- Start the engine and recirculate the fuel. Make sure that all tank valves are open, the recirculation valve is open, and the recirculation switch is on.
- Add one to two 4-litre containers of Petrol Jel for every 50 gallons of fuel to achieve the desired consistency. Recirculate the fuel while adding Petrol Jel.
- Continue to recirculate the fuel until all of the Petrol Jel has been added and allowed to set up.
- Do not start mixing fuel until the burn operation is confirmed because the gel will break down quickly.

## FLASH 21

- Flash 21 is ICL Performance Products' (formerly Fire-Trol Canada) new fuel gelling agent (figure 10–5). This two-part liquid gelling agent:
- Provides fast, reliable gelling.
- Must be added to fuel as two parts (A and B)—1 liter of each.
- One box of Flash 21 has 12 liters of product, 6 of Flash 21A and 6 of Flash 21B. One liter of Flash 21A and one liter of Flash 21B will gel 50 to 55 gallons of fuel.
- Mixes with various fuels including nonoxygenated gasoline, Avgas, diesel, Jet A, and JP8.
- Allows users to mix this product with fuel regardless of temperature, ensuring a consistent gelled fuel mixture.
- Will not lose viscosity, allowing the gel to be used during the entire burning operations.
- Mixes and disperses throughout the fuel with no lumping and sets up quickly.

Figure 10–5—Flash 21 is a two-part liquid gelling agent that gels quickly and stays gelled for a long time.



#### *Mixing Procedures for Flash 21*

- Make sure that the mixing tank is clean.
- Fill the mixing tank with the desired amount of fuel.
- Start the engine and recirculate the fuel. Make sure that all tank valves are open, the recirculation valve is open, and the recirculation switch is on.
- Add 1 liter (or the desired amount) of Flash 21A for every 50 gallons of fuel, continue recirculating the fuel.
- After the Flash 21A has been added, add an equal amount of Flash 21B. Continue recirculating the fuel.
- The fuel will gel to the desired viscosity in less than 10 minutes. Warm temperatures will not affect the gel's quality.
- If the operator wants to thicken the gel, additional Flash 21 may be added, using equal amounts of each component. Make sure the Flash 21A is thoroughly mixed in the gel before adding the Flash 21B.
- If the fuel will not gel because it contains ethanol, try the following:
  - Determine the amount of gasoline in the fuel mixture.
  - Add water (5 percent of the gasoline volume) to the fuel mixture and recirculate.
  - If the resulting gel is too thin, add a bottle of Flash 21A and recirculate until the Flash 21A is thoroughly mixed with the fuel. Continue recirculating the fuel and add a bottle of Flash 21B.
  - If too much water was added, a small amount of free water may be present in the gel. This should have only a small effect on the performance of the gel. If free water is present, reduce the amount of water used in the next batch of gel.
- **Unused gelled fuel made with Flash 21 may be stored in the mix tank and used later with no adverse effects to the fuel. However, tank lining deterioration or corrosion may accelerate and tanks should be routinely inspected for these conditions.**
- **Recirculate stored gelled fuel prior to dispensing to remix components that may have separated.**



## Safety Preparations

Conduct a safety briefing that at a minimum:

- Identifies terra torch operations, fire protection, and first aid personnel.
- Ensures all personnel involved in the burn understand their roles and responsibilities.
- Ensures all personnel understand the burn and the firing and contingency plan (objectives of the burn and firing sequences to be followed as well as contingencies in place in the event the fire crosses control lines).
- Identifies escape routes and an emergency meeting place (rally point) where personnel could congregate to ensure everyone is accounted for and safe.
- Describes the medical evacuation plan.
- Describes procedures in the event of an equipment malfunction.
- Describes procedures to be used if the terra torch catches fire, ensuring personnel safety and extinguishment of the fire, if possible.
- Ensures the LCES checklist has been reviewed and implemented.
- Ensures the following radio frequencies have been established, checked, and reviewed:
  - Terra torch module to burn boss
  - Operator to driver
  - Burn boss to dispatch/ICP

### PREPARE THE EQUIPMENT FOR BURNING:

- Place fire extinguisher(s) in accessible location(s) within ready reach of the driver and the terra torch operator. The extinguisher(s) shall be located away from the fuel tank.
- Remove the wand and torch hose(s) from the storage rack.
- Connect the end of the torch's hose to the quick disconnect coupler at the pump.
- Plug the electrical connection for the torch wand into the receptacle at the control panel (figure 10–6).
- Attach the propane cylinder to the wand.
  - Install the propane cylinder onto the propane gas hose. Tighten by hand.
  - Mount the cylinder to the wand and secure with two clamps.
  - Make sure the propane gas valve is closed.
- As required, loosen the setscrew and slide the igniter bracket along the barrel to position the igniter as shown (figure 10–7). Tighten the setscrew.
- As required, adjust the position of the grip handle. Turn the handle counterclockwise (to the left) to loosen, slide the grip handle along the barrel to the desired position, then turn the handle clockwise (to the right) to tighten.

#### Caution

The emergency rally point should be identified (OSHA 29 CFR 1910.38). Emergency escape route, emergency shutdown of operations, procedures to account for all employees, rescue and medical duties, and means of reporting fires and emergencies should be covered. The alarm system to be used for employee notification should be outlined.

Figure 10–6—The terra torch control panel showing the three-way switch in the OFF position.



Figure 10–7—Position the igniter as shown to ensure reliable ignition.



## Normal Operating Procedures for Terra Torches

Follow these procedures when using a terra torch.

### Preparing the Torch for Use

- To purge any residual fuel in the torch hose and wand:
  - Start the engine.
  - Close the recirculation valve.
  - Open the torch shutoff valve at the pump.
  - Set the three-way switch to the TORCH position.
  - Point the wand in the direction of desired ignition and dispel all unused fuel.
  - Set the three-way switch to the OFF position and shut down the engine (see figure 10–6).

### Igniting the Torch

- Open the propane gas valve fully and ignite the propane.
- Adjust the propane flame by closing the gas valve to create the minimum flame required to ignite the gel consistently.

### Using the Torch

- Restart the engine, move the three-way switch to the TORCH position, squeeze the wand trigger, and begin the firing operation.
- Direct the burning gel toward the vegetation to be burned.
- Fire from the rear of the terra torch vehicle. Direct the burning gel outward at an angle and **only** to the area behind the vehicle.
- Make sure that the tailgate is open to prevent fumes from pooling in the truck's bed.
- To produce optimal gel coverage, the operator will need to experiment and learn from experience. The wand is factory-equipped with a No. 12 orifice disc at its tip. The orifice disc may be replaced with discs with different sizes of orifices, depending on the desired results.
  - Increase or decrease pressure, by adjusting the terra torch engine's revolutions per minute, to adjust the distance of the gel stream.

- To improve firing in a crosswind, adjust the angle of the propane torch:
  - Loosen the nut at the end of the igniter bracket until the torch can be moved by hand.
  - Rotate the torch 90 degrees left or right so it is on the windward side of the wand tip.
  - Tighten the nut (at the end of the igniter bracket).
- To stop firing after a firing sequence is complete:
  - Release the trigger and close the propane gas valve.
  - Set the three-way switch to the OFF position.

### Shutting Down the Torch

- When firing operations are completed:
  - Purge the hose and wand of any gelled fuel as described previously (see the “[Preparing the Torch for Use](#)” section in this chapter).
  - Close the torch shutoff valve at the pump.
  - Close the propane gas valve to conserve gas whenever you are not firing.

### Emergency Operating Procedures for Terra Torches

Terra torch operators need to know what to do in the following situations:

- General
  - If the terra torch malfunctions, shut down the torch until all problems are identified and corrected.
  - Establish emergency contact procedures using radio notification.
- Torch catches fire—if time and fire size permit attempts to extinguish the fire:
  - Shut down torch.
  - Close the tank’s emergency valves.
  - Attempt to extinguish the fire using a Class B fire extinguisher or Class B foam, if practical.
- Torch catches fire—if time and fire size do not permit attempts to extinguish the fire:
  - Abandon the torch and leave the area immediately.
- Major fuel spill
  - Eliminate all sources of ignition in the area.
  - Remove all personnel from the area.
  - Restrict access to the area.
  - Contact your local hazardous materials coordinator or environmental coordinator.

#### Caution

If the torch catches fire, do not jeopardize your safety to save the torch or the vehicle!

## TROUBLESHOOTING

### Terra Torch Troubleshooting Procedures

Malfunction	Test or inspection	Corrective action
Clutch does not engage the pump	Make sure the three-way switch is set to TORCH, RECIRCULATE, or MIX-TRANSFER.	Set the three-way switch to TORCH, RECIRCULATE, or MIX-TRANSFER. If the switch position is correct, proceed to the next step.
	Check the V-belts on the clutch.	If the V-belts are loose, tighten the V-belts. If the V-belts are worn or damaged, replace the V-belts. If the V-belts are not loose or damaged, proceed to the next step.
	Check the wiring system for damage.	Repair damaged wiring. If the wiring is not damaged, proceed to the next step.
	Make sure the battery has enough charge to activate the clutch. Set the three-way switch to TORCH, squeeze the wand's trigger, and listen for the clicking sound of the clutch being activated. Set the three-way switch to RECIRCULATE and listen for the clicking sound.	If there is no clicking sound, check the battery's charge. Charge or replace the battery. If there is a clicking sound, repair or replace the clutch.
Engine will not start	Make sure the fuel tank has fuel.	If the fuel tank is empty, fill the tank with fuel. If the tank has fuel, proceed to the next step.
	Make sure the fuel shutoff valve is open.	If the fuel shutoff valve is closed, open the fuel shutoff valve. If the fuel shutoff valve is open, proceed to the next step.
	Make sure the choke control lever is in the CHOKE position.	If the choke control lever is not in the CHOKE position, move the lever to the CHOKE position. If the choke control lever is in the CHOKE position, proceed to the next step.
	Make sure the throttle control is in the SLOW (IDLE) position.	If the throttle control lever is not in the SLOW (IDLE) position, move the lever to the SLOW (IDLE) position. If the throttle control lever is in the SLOW (IDLE) position, proceed to the next step.
	Inspect the battery and electrical connections.	If the battery or electrical connections are damaged, repair or replace the battery or electrical connections. If the battery and electrical connections are intact, proceed to the next step.
	Remove and inspect the spark plug.	If the spark plug is dirty or damaged clean or replace the spark plug. If the engine will not start, consult the engine manual or a small engine mechanic.

<b>Malfunction</b>	<b>Test or inspection</b>	<b>Corrective action</b>
No flame or weak flame at the propane torch	Make sure the propane valve is open.	If the propane valve is not open, open the valve. If the valve is open, proceed to the next step.
	Make sure the propane cylinder is not empty.	If the propane cylinder is empty, replace the propane cylinder. If the propane cylinder is not empty, proceed to the next step.
	Make sure the orifice disc in the propane torch is not blocked.	If the orifice disc is blocked, clean the orifice. If the orifice disc is not blocked, proceed to the next step.
	Inspect the propane fittings and hose for damage. Check for dirt, debris, or other obstructions at the igniter's orifice.	Replace damaged fittings or hose. Clean the igniter orifice with welding tip cleaners.
Pump does not operate	Make sure the clutch engages the pump.	If the clutch does not engage the pump, troubleshoot the clutch. If the clutch does engage the pump, proceed to the next step.
	Check the pump pressure.	Close the recirculation valve, set the switch to RECIRCULATE and check the gauge for pressure rise. If the pressure does not increase, repair or replace the pump.
Trigger on the torch does not activate the clutch	Make sure the torch hose electrical plugs are connected to the receptacles.	If the torch hose electrical plugs are not connected, connect them. If the torch hose electrical plugs are connected, proceed to the next step.
	Check the wiring from the torch to the clutch for damage.	If the wiring is damaged, repair the wiring. If the wiring is not damaged, proceed to the next step.
	Make sure the battery has enough charge to activate the clutch. Set the three-way switch to TORCH, squeeze the wand's trigger, and listen for the clicking sound of the clutch being activated. Set the three-way switch to RECIRCULATE and listen for the clicking sound.	If there is no clicking sound, check the battery's charge. Charge or replace the battery. If there is a clicking sound, repair or replace the clutch.
Unit fails to pump gel to the torch	Make sure the three-way switch is set to TORCH.	Set the three-way switch to TORCH. If the switch position is correct, proceed to the next step.
	Make sure the recirculation valve is closed.	If the recirculation valve is open, close the recirculation valve. If the recirculation valve is closed, proceed to the next step.

Malfunction	Test or inspection	Corrective action
Unit fails to pump gel to the torch	Make sure the torch shutoff valve is open.	If the torch shutoff valve is closed, open the torch valve. If the torch shutoff valve is open, proceed to the next step.
	Make sure the tank valves are open.	If the tank valves are closed, open the tank valves. If the tank valves are open, proceed to the next step.
	Make sure the torch hose electrical and quick coupler connections are made and are secure.	Connect the electrical and quick coupler connections. If the connections are correct, proceed to the next step.
	Make sure the gel is not too thick.	If the gel is too thick, thin the gel. If the gel is the proper consistency, proceed to the next step.
	Make sure the battery has enough charge to activate the clutch. Set the three-way switch to TORCH, squeeze the wand's trigger, and listen for the clicking sound of the clutch being activated. Set the three-way switch to RECIRCULATE and listen for the clicking sound.	If there is no clicking sound, check the battery's charge. Charge or replace the battery. If there is a clicking sound, proceed to the next step.
	Make sure the gel has not formed a lump at the bottom of the tank.	If the gel has formed a lump at the bottom of the tank, cycle the tank outlet valve open and closed to dislodge the blockage. If the gel has not formed a lump at the bottom of the tank, proceed to the next step.
	Make sure the quick coupler is not blocked.	If the quick coupler is dirty, turn off the terra torch, close the torch shutoff valve, and remove the male end of the quick connect and clean it. If the quick coupler is not dirty, troubleshoot the pump.

<b>Malfunction</b>	<b>Test or inspection</b>	<b>Corrective action</b>
Unit fails to recirculate the gel	Make sure the three-way switch is set to RECIRCULATE.	Set the three-way switch to RECIRCULATE. If the switch position is correct, proceed to the next step.
	Make sure the recirculation valve is open.	If the recirculation valve is closed, open the recirculation valve. If the recirculation valve is open, proceed to the next step.
	Make sure the torch shutoff valve is closed.	If the torch shutoff valve is open, close the torch valve. If the torch shutoff valve is closed, proceed to the next step.
	Make sure the tank valves are open.	If the tank valves are closed, open the tank valves. If the tank valves are open, proceed to the next step.
	Make sure the battery has enough charge to activate the clutch. Set the three-way switch to RECIRCULATE and listen for the clicking sound of the clutch being activated.	If there is no clicking sound, check the battery's charge. Charge or replace the battery. If there is a clicking sound, proceed to the next step.
	Make sure the gel is not too thick.	If the gel is too thick, thin the gel. If the gel is the proper consistency, proceed to the next step.
	Make sure the gel has not formed a lump at the bottom of the tank.	If the gel has formed a lump at the bottom of the tank, cycle the tank outlet valve open and closed to dislodge the blockage. If the gel has not formed a lump at the bottom of the tank, troubleshoot the pump.
Wand leaks at the handle	Make sure that the packing screw at the handle is tight.	Tighten the packing screw. If the packing screw is tight, proceed to the next step.
	Disassemble the wand and inspect the packing washer and the packing for compaction or damage.	Replace as needed.
Wand leaks at the tip	Make sure the brass cap at the end of wand is tight.	Tighten the brass cap. If the brass cap is tight, proceed to the next step.
	Disassemble the tip and make sure the nylon gasket is present and not damaged. Make sure an O-ring has not been used instead of the nylon gasket.	Install or replace the nylon gasket as needed.
Wand's trigger sticks	Make sure that the packing screw at the handle has not been overtightened.	Loosen the packing screw. If the packing screw has not been overtightened, proceed to the next step.
	Inspect the barrel of the wand to make sure it has not been dented. If the barrel is dented, the guide vane can stick.	Disassemble the wand and replace the damaged parts.

## Maintenance and Storage

The terra torch and mixing unit must be properly maintained to work reliably.

### Cleaning and Repair

- Internal Cleaning
  - Add 5 gallons of diesel fuel to the tank.
  - Place the unit in the recirculation mode and recirculate diesel for 5 minutes.
  - Set the three-way switch to TORCH. Close the RECIRCULATION valve and open the torch valve.
  - With the propane cylinder removed, pump the liquid through the hose and wand and dispose of the liquid by burning it at the burn site.
  - Add an additional 5 gallons of diesel fuel to the tank.
  - Place the unit in the recirculation mode and recirculate the diesel fuel for 5 minutes.
  - Set the three-way switch to TORCH. Close the RECIRCULATION valve and open the torch valve.
  - Pump the liquid through the hose and wand into the tank.
  - Use the liquid in the tank for the next batch of gel.
- External Cleaning
  - Use solvent to remove hardened gel and powder from the outside of the motor compartment. Wash the unit with soap and water.
  - Use only mild soap and water on the stainless steel tank.
- Preventative Maintenance
  - Grease the pump and shaft bearings according to the manufacturer's instructions.
  - Change the engine oil and filter as needed. Refer to the engine manual for additional service.
  - Keep a record of all maintenance.

### Storing Equipment and Fuel

- Store all equipment indoors or cover the equipment well.
- Store gelling agents in warehouses, keeping powdered gelling agents in dry, heated locations. Consult the links to the safety data sheets ([appendix A](#)) and your local hazmat coordinator for additional storage requirements.

### Terra Torch Resources

This section includes the following resources:

- Information for inclusion in a hazard analysis
- List of required safety data sheets
- Using a dust mask
- Recommended spare parts
- Equipment standards for terra torches
- Contract equipment inspection checklist
- Terra torch references



## Hazard Analysis

This information can be used when preparing a job hazard analysis (used by the Forest Service) or similar hazard analysis.

### Caution

If gelled fuel is spilled, the preferred method of clean up is to burn the gelled fuel onsite. Consult with your local safety officer before cleaning or maintaining the interior of batch or modular mixers or cleaning up spills to determine the appropriate respiratory protection and other PPE.

### Information for Terra Torch Hazard Analyses

Task	Hazards	Abatement actions
Transporting the terra torch	Torch falling off of the vehicle or trailer	Make sure the terra torch is secured to the vehicle or trailer.
Filling the tank and mixing fuel	Fuel spills Inhaling gel compound and gasoline fumes Static electricity (sparks) Eye and skin contact	Wear static-resistant Nomex or cotton clothing and nitrile gloves while mixing gelled fuel. Use safety cans with pour spouts. Electrically bond the unit with the proper static line. Avoid breathing fuel vapors. Wear the required personal protective equipment (PPE). Change flame-resistant clothing if fuel spills on clothing. Use eye wash station onsite.
Assembling components of the terra torch	Fuel spills Breathing fuel vapors Static electricity (sparks)	Wear the required PPE. Check for fuel leaks. Tighten all hose connections. Avoid breathing fuel vapors.
Igniting the terra torch	Burns Fumes Noxious smoke	Wear the required PPE. Be aware of the location of the wand's tip. Use proper ignition methods to light the propane torch. Avoid breathing fuel vapors.
Burning operations	Burns Fumes Noxious smoke Dragging the torch operator with the vehicle Tripping, stumbling, or falling Eye and skin contact	Wear the required PPE. Be aware of where the wand tip is pointing. Only ignite vegetation behind the torch vehicle or trailer. When not firing, keep your fingers off the trigger. Move the vehicle slowly ahead of the operator. Make sure an assistant will control movement of the excess hose. Make sure the operator has secure footing. Avoid breathing fumes. Wear the required PPE. Change flame-resistant clothing if fuel spills on clothing. Use eye wash station onsite.
Extinguishing the terra torch	Fuel or gel spills	Wear the required PPE. Be aware that fuel may leak from the wand's tip.
Cleaning the terra torch	Fuel vapors Fuel on skin Fuel spills Eye and skin contact	Wear nonstatic Nomex or cotton clothing and nitrile gloves. Minimize exposure to fuel vapors and contact with the fuel. Clean up all fuel spills promptly. Wear the required PPE. Change flame-resistant clothing if fuel spills on clothing. Use eye wash station onsite.

## List of Required Safety Data Sheets

Links to safety data sheets for ground ignition systems are in [appendix A](#). The safety data sheets for the terra torch include:

- Diesel
- Fire-Trol Firegel
- Fire-Trol Petrol Jel
- Fire-Trol Flash 21A
- Fire-Trol Flash 21B
- Gasoline
- Propane

## Using a Dust Mask

When dispensing or handling powdered gelling agent, if providing dust masks for voluntary use (as defined by OSHA in *29 CFR 1910.134*) make sure that you:

- Supply a dust mask rated N95 (blocks about 95 percent of particles that are 0.3 microns or larger).
- Prevent contamination of N95 dust masks by storing them in a chemical- and dust-free sealed container.
- Make sure the N95 dust mask does not interfere with employees' ability to work safely.
- Instruct employees that the N95 masks are for one-time use and a new one should be used each day.
- Make sure each employee reads a copy of appendix D of *29 CFR 1910.134*, which instructs employees on N95 dust mask limitations (warning them that wearing a dust mask does not protect them from organic vapors).

## OSHA Appendix D to Sec. 1910.134

### (Mandatory) Information for Employees Using Respirators When Not Required Under the Standard

Respirators are an effective method of protection against designated hazards when properly selected and worn. Respirator use is encouraged, even when exposures are below the exposure limit, to provide an additional level of comfort and protection for workers. However, if a respirator is used improperly or not kept clean, the respirator itself can become a hazard to the worker. Sometimes, workers may wear respirators to avoid exposures to hazards, even if the amount of hazardous substance does not exceed the limits set by OSHA standards. If your employer provides respirators for your voluntary use, or if you provide your own respirator, you need to take certain precautions to be sure that the respirator itself does not present a hazard.

You should do the following:

1. Read and heed all instructions provided by the manufacturer on use, maintenance, cleaning and care, and warnings regarding the respirators limitations.
2. Choose respirators certified for use to protect against the contaminant of concern. NIOSH, the National Institute for Occupational Safety and Health of the U.S. Department of Health and Human Services, certifies respirators. A label or statement of certification should appear on the respirator or respirator packaging. It will tell you what the respirator is designed for and how much it will protect you.
3. Do not wear your respirator into atmospheres containing contaminants for which your respirator is not designed to protect against. For example, a respirator designed to filter dust particles will not protect you against gases, vapors, or very small solid particles of fumes or smoke.
4. Keep track of your respirator so that you do not mistakenly use someone else's respirator.

—63 FR 1152, Jan. 8, 1998; 63 FR 20098, April 23, 1998]

## Recommended Spare Parts

- Drive belts for pump
- Spare wand and hose
- Extra tips for the wand
- Packing for the wand
- Spark plug for the engine
- Engine fuel filters
- Engine air filter
- Engine oil
- Propane cylinders

## Equipment Standards for Terra Torches

The minimum equipment standards that must be met are listed. Additional agency-specific standards may be required.

### FUEL TANK REQUIREMENTS

- Tanks or drums with a capacity of 55 gallons or greater must meet DOT specifications for transporting flammable liquids.
- Tanks with a capacity of less than 55 gallons must be leak free.
- Tanks larger than 119 gallons must have a FLAMMABLE placard and the 1203 UN identification number installed on all four sides of the tank or on the sides of the tank and the front and back of the transport vehicle. The 1203 identification number may be displayed separately or as part of the FLAMMABLE placard.
- Tanks or drums with a capacity of 119 gallons or less must have a FLAMMABLE LIQUID label installed and be marked GASOLINE, UN 1203.
- Tanks with a capacity larger than 119 gallons must have an emergency shutoff valve that is marked and easily accessible in the event of an emergency.
- Bolt or weld the tank to the skid or trailer frame. Bolting the tank to the trailer's expanded metal decking is not acceptable.
- Tanks with a capacity of larger than 119 gallons shall be installed so that the emergency shutoff valves are protected and not protruding from the vehicle.
- Tanks larger than 60 gallons shall be equipped with a fill spout that extends to within 6 inches of the tank bottom or be equipped to fill from the bottom to prevent static electricity from building up and discharging.
- All tanks or drums 55 gallons or larger shall be equipped with a 2-inch male camlock (cam and groove adapter) by male NPT (national pipe taper) thread for use with the vapor recovery/removal hoses. A dust cap shall be provided with the adapter to prevent contaminating the tank when the vapor hose is not being used.
- Tanks or drums must be equipped with a means such as a hatch or sight glass to see the fuel level.
- Tanks or drums must be equipped with a relief valve to allow air to enter and exit during pumping operations.

## **PUMP**

- Must have nonsparking internal components.
- Must have seals and gaskets that are compatible with gasoline.
- Must be designed to operate at the system's pressure and flow rate.
- Must be designed to operate at the design revolutions per minute of the system.

## **PUMP RELIEF VALVE**

- The system must be equipped with a relief valve to prevent excessive pressure from building up if the pump's discharge piping is blocked.
- The discharge of the relief valve may be connected to the pump inlet or to the tank.
- The relief valve must be sized for full pump flow.
- The relief pressure setting must not exceed the pressure ratings of any of the system's components.
- All of the materials, including the seals and gaskets, must be compatible with gasoline.

## **ELECTRICAL REQUIREMENTS**

- Permanently seal electrical connections to prevent sparks.
- Install a protective housing over switch housings to reduce sparks.
- Install the battery in an enclosed battery holder as far away as possible from potential sources of fuel leakage. The battery shall be connected to the terra torch engine with No. 4 cables encased in plastic conduit. The conduit shall be secured to the terra torch skid or vehicle bed. Alternatively, the terra torch may be connected to the vehicle's battery using No. 4 cables.
- Protect wiring from abrasion using split loom, conduit, or other methods. Electrical tape is not considered adequate. Where wiring passes through frame members, it shall be protected by rubber grommets to protect the insulation.

## **ENGINE INSTALLATION**

- Locate the fuel tank so the engine can be refueled without spilling fuel on a hot engine.
- Shield the engine or piping so that leaks in any of the piping, pump seals, hoses, or other components cannot spray gasoline or gel on a hot engine. The shielding shall not interfere with the cooling of the engine.

## **HOSES, PIPING, VALVES, AND FITTINGS**

- All hoses, piping, valves, and fittings shall be sized to allow adequate flow for mixing the fuel and gelling agent and for dispensing the fuel through the wand.
- All piping must be supported and secured.
- Hose installations shall be protected from abrasion.
- All hose assemblies shall have swaged end fittings.
- All hose assemblies shall be conductive.
- All cam and groove fittings shall be equipped with self locking levers or be provided with other means to prevent the levers from releasing accidentally.
- All valves shall be permanently labeled, indicating their function and direction of flow.
- The pressure gauge shall be isolated from the gelled fuel by a diaphragm assembly.

## VAPOR REMOVAL AND RECOVERY

- Each terra torch of 55 gallons or greater capacity shall be equipped with a vapor removal/recovery hose.
- The minimum hose length is 50 feet.
- The hose assembly shall be electrically conductive.
- The hose shall be compatible with gasoline vapor.
- The hose shall be equipped with a 2-inch male camlock (cam and groove adapter) by male NPT (national pipe taper) thread.

## BONDING

- Each terra torch shall be equipped with an electrical bonding cable to be used during fueling.
- The terra torch must remain electrically bonded to the transport vehicle while on the vehicle.

## SECURING THE TORCH TO THE VEHICLE

- The torch shall be secured to the vehicle or trailer so that it does not move during transit or during the firing operation.

### *Trailer (Forest Service only)*

If the terra torch is mounted on a trailer, the trailer must be equipped with brakes if the gross trailer weight rating is 1,500 pounds or more. The brakes must be designed so the operator can activate them independently of the vehicle foot brakes (FSH 7109.19, 31.3).

## Contract Equipment Inspection Checklist

### FUEL TANKS

- Fuel tanks or drums with a capacity of 55 gallons or more meet DOT specifications for transporting of flammable liquids.
- Fuel tanks with a capacity of less than 55 gallons are leak free.
- Tanks larger than 119 gallons have a FLAMMABLE placard and the 1203 UN identification number installed on all four sides of the tank or on the sides of the tank and the front and back of the transport vehicle. The 1203 identification number is displayed separately or as part of the FLAMMABLE placard.
- Drums or tanks with a capacity of 119 gallons or less have a FLAMMABLE LIQUID label installed and are marked GASOLINE, UN 1203.
- The tank emergency shutoff valve is marked and easily accessible in an emergency.
- The tank is bolted or welded to the skid or trailer frame. Bolting the tank to expanded metal decking is not acceptable.
- The tank or drums are installed so the emergency shutoff valves are protected and not protruding from the vehicle.
- Tanks larger than 60 gallons are equipped with a fill spout that extends to within 6 inches of the tank bottom or are equipped to fill from the bottom to prevent static electricity from building up and discharging.
- All tanks or drums 55 gallons or larger are equipped with a 2-inch male camlock (cam and groove adapter) by male NPT (national pipe taper) thread for use with the vapor recovery/removal hoses. A dust cap is provided with the adapter to prevent the tank from being contaminated when the vapor hose is not being used.
- Tanks or drums are equipped with a means to visually determine the fuel level.
- Tanks or drums are equipped with a relief valve to allow air to enter and exit during pumping operations.

## **PUMP**

- The pump has nonsparking internal components.
- Pump seals and gaskets are compatible with gasoline.
- The pump is designed to operate at the system's pressure and flow rate.
- The pump is designed to operate at the system's design revolutions per minute.

## **RELIEF VALVE**

- The system is equipped with a relief valve to prevent excessive pressure from building up if the pump's discharge piping is blocked.
- The relief valve's discharge is connected to the pump inlet or to the tank.
- The relief valve is sized for full pump flow.
- The relief pressure setting does not exceed the pressure ratings of any of the system's components.
- All materials, including seals and gaskets, are compatible with gasoline.

## **ELECTRICAL**

- Electrical connections are permanently sealed to prevent sparks.
- A protective housing is installed over switch housings to reduce sparks.
- The battery is installed in an enclosed battery holder as far away as possible from potential sources of fuel leakage.
- The battery is connected to the engine with No. 4 cables encased in plastic conduit. The conduit is secured to the terra torch's skid or vehicle bed.
- Wiring is protected from abrasion by split loom, conduit, or other methods. Electrical tape is not considered adequate. Where wiring passes through frame members, it is protected by rubber grommets to protect the insulation.

## **ENGINE**

- The engine's fuel tank is located so the engine can be refueled without spilling fuel on a hot engine.
- The engine or piping is shielded so that leaks in any of the piping, pump seals, hoses, or other components cannot spray gasoline or gel on a hot engine. The shielding does not interfere with cooling of the engine.

## **PIPING AND HOSES**

- All hoses, piping, valves, and fittings are sized to allow adequate flow for mixing the fuel and gelling agent and for dispensing the fuel through the wand.
- All piping is supported and secured.
- Hose installations are protected from abrasion.
- All hose assemblies have swaged end fittings.
- All hose assemblies are conductive.
- All cam and groove fittings are equipped with self-locking levers or have other means to prevent the levers from releasing accidentally.
- All valves are permanently labeled, indicating their function and the direction of flow.
- The pressure gauge is isolated from the gelled fuel by a diaphragm assembly.

#### VAPOR REMOVAL AND RECOVERY

- Each terra torch 55 gallons or larger is equipped with a vapor removal and recovery hose.
- The vapor hose length is at least 50 feet long.
- The vapor hose is electrically conductive.
- The vapor hose is compatible with gasoline vapor.
- The vapor hose is equipped with a 2-inch cam and groove (camlock) socket.

#### BONDING

- The torch is equipped with a retractable bonding cable that prevents static electricity from building up when the terra torch is fueled.
- The bonding cable assembly is electrically bonded to the terra torch's fuel tank.

#### MISCELLANEOUS

- All of the materials, including the seals and gaskets, must be compatible with gasoline.
- The torch is secured to the vehicle or trailer so that it does not move during transit or during the firing operation.
- If the terra torch is mounted on a trailer, if the gross trailer weight rating is 1,500 pounds or more the trailer must be equipped with brakes. The brakes must be designed so the operator can activate them independently of the vehicle foot brakes (Forest Service requirement—FSH 7109.19, 31.3).

#### Terra Torch References

See [appendix B](#) for additional ground ignition references.

*Interagency Standards for Fire and Fire Aviation Operations*, NFES 2724, available at [http://www.nifc.gov/policies/pol\\_ref\\_redbook.html](http://www.nifc.gov/policies/pol_ref_redbook.html).

*NWCG Standards for Transporting Fuel*, PMS 442, available at <http://www.nwcg.gov/publications/442>.

*Everyday HazMat User's Training Guide*, 0471–2810–MTDC, available at [https://www.fs.usda.gov/t-d/everyday\\_hazmat](https://www.fs.usda.gov/t-d/everyday_hazmat).

*29 CFR 1910*, available at <http://www.osha.gov>. (Search for 29 CFR 1910.)

*Forest Service Handbook* FSH 7109.19, 31.3, available at [https://www.fs.usda.gov/cgi-bin/Directives/get\\_dirs/fsh?7109.19](https://www.fs.usda.gov/cgi-bin/Directives/get_dirs/fsh?7109.19).

Phos-Chek Web site at <http://phoschek.com>.





## Appendix A—Safety Data Sheets

Below is a list of links to useful safety data sheets:

- Flares and cartridges
  - FireQuick flares
    - <[http://www.firequick.com/content.php?\\_p\\_=3](http://www.firequick.com/content.php?_p_=3)>.
  - Orion flares
    - 12 Gauge HP Red Aerial Signal
      - <<http://www.orionsignals.com/images/stories/msds/12ga.pdf>>
    - 12 Gauge White Aerial Flare
      - <<http://www.orionsignals.com/images/stories/msds/12ga%20white.pdf>>.
  - Cartridges (industrial loads) for FireQuick Flare Systems
    - <<http://winchester.com/SiteCollectionDocuments/pdf/SDS/CARTRIDGES,%20RIMFIRE%20BLANK.pdf>>
- Fire extinguishers <[http://dms.hvacpartners.com/docs/2001/Public/02/MSDS\\_Commercial-ABC\\_FKAKidde55.pdf](http://dms.hvacpartners.com/docs/2001/Public/02/MSDS_Commercial-ABC_FKAKidde55.pdf)>
- Fuels
  - Diesel
    - Diesel no. 1
      - <[https://www.sinclairoil.com/sites/default/files/MSDS.Fuels\\_.Diesel%20No%201.pdf](https://www.sinclairoil.com/sites/default/files/MSDS.Fuels_.Diesel%20No%201.pdf)>
    - Diesel no.2
      - <[https://www.sinclairoil.com/sites/default/files/MSDS.Fuels\\_.Diesel%20No%202.pdf](https://www.sinclairoil.com/sites/default/files/MSDS.Fuels_.Diesel%20No%202.pdf)>
  - Gasoline
    - <[https://www.sinclairoil.com/sites/default/files/MSDS.Fuels\\_.Gasoline.pdf](https://www.sinclairoil.com/sites/default/files/MSDS.Fuels_.Gasoline.pdf)>
    - Gasoline with ethanol
      - <[https://www.sinclairoil.com/sites/default/files/MSDS.Fuels\\_.Gasoline%20with%20Ethanol.pdf](https://www.sinclairoil.com/sites/default/files/MSDS.Fuels_.Gasoline%20with%20Ethanol.pdf)>
    - Gasoline all grades
      - <<https://www.hess.com/docs/us-safety-data-sheets/gasoline-all-grades.pdf?sfvrsn=2>>
  - Jet Fuel
    - Jet fuel A
      - <[https://www.sinclairoil.com/sites/default/files/MSDS.Fuels\\_.Jet%20Fuel.pdf](https://www.sinclairoil.com/sites/default/files/MSDS.Fuels_.Jet%20Fuel.pdf)>
    - Kerosene K1 and K2
      - <[https://www.hess.com/docs/eu-safety-data-sheets/kerosene\\_eu.pdf?sfvrsn=2](https://www.hess.com/docs/eu-safety-data-sheets/kerosene_eu.pdf?sfvrsn=2)>
- Fusees
  - Orion fusees
    - <<http://www.orionsignals.com/images/stories/msds/backfire.pdf>>.
- Gases

- Carbon dioxide  
<<http://www.praxair.com/~media/praxairus/documents/sds/carbon%20dioxide/carbon%20dioxide%20medipure%20co2%20safety%20data%20sheet%20sds%20p4574.pdf?la=en>>
- Nitrogen  
<<https://www.airgas.com/msds/001040.pdf>>
- Propane  
<<https://w3apps.phillips66.com/NetMSDS/ViewPDF.aspx?fileName=169570&Language=EN&IssueDate=7%2f18%2f2017&SubFormat=USDS>>
- Gelling agents
  - Fire-Trol Flash 21A  
<<http://www.icl-pp.com/MSDS/Fire-Safety/Phos-Chek%20Flash%2021%20A%202011.pdf>>.
  - Fire-Trol Flash 21B  
<<http://www.icl-pp.com/MSDS/Fire-Safety/Phos-Chek%20Flash%2021%20B%202011.pdf>>.
- Gelled fuel blivets
  - FireSnakes/Heat Source Slash Burners—available at  
<<https://industryrailway.com/wp-content/uploads/2016/12/Safety-Data-Sheet.pdf>>.
- Oils
  - Bar and Chain oil <[https://www.stihlusa.com/WebContent/CMSFileLibrary/MSDS/Stihl\\_Platinum\\_Bar\\_Chain.pdf](https://www.stihlusa.com/WebContent/CMSFileLibrary/MSDS/Stihl_Platinum_Bar_Chain.pdf)>
  - 2 cycle oil  
<<https://www.stihlusa.com/WebContent/CMSFileLibrary/MSDS/STIHL2CYHP.pdf>>
- Plastic spheres
  - Ethylene glycol antifreeze  
<<https://www.fishersci.com/msdsproxy%3FproductName%3DE1774%26product-Description%3DETHYLENE%2BGLYCOL%2BLABORATORY%2B4L%26cat-No%3DE177-4%2B%26vendorId%3DVN00033897%26storeId%3D10652>>
  - Potassium permanganate  
<<http://www.sciencelab.com/msds.php?msdsId=9927406>>

## Appendix B—Ground Ignition References

This appendix is a compilation of the references found in individual chapters and additional references.

### Drip Torches

- *Specification 5100-614A, Drip Torch (Diesel and Gasoline Mixture)*, available at <<https://www.fs.usda.gov/t-d/programs/fire/specs.htm>>.
- *Specification 5100-616, Drip Torch-Extended Spout (Diesel and Gasoline Mixture)*, available at <<https://www.fs.usda.gov/t-d/programs/fire/specs.htm>>.
- *Fire Equipment Storage and Refurbishing Standards, PMS 448*, available at <<http://www.nwcg.gov/publications/448>>.

### Flares and Flare Launchers

- *FireQuick Flare Systems User Training Workbook*, available from FireQuick Products, Inc., 855-374-3473.

### Fusees

- *Specification 5100-360F, Fusee, Backfiring*, available at <<https://www.fs.usda.gov/t-d/programs/fire/specs.htm>>.

### Hazardous Materials

- *Emergency Response Guidebook*, available at <<http://www.phmsa.dot.gov/hazmat/>>. (Search for Emergency Response Guidebook.)
- *Everyday HazMat User's Training Guide, 0471-2810-MTDC*, available at <[https://www.fs.usda.gov/t-d/everyday\\_hazmat](https://www.fs.usda.gov/t-d/everyday_hazmat)>.
- *NWCG Standards for Aviation Transport of Hazardous Materials, PMS 513*, available at <<https://www.nwcg.gov/publications/513>>.

### Plastic Spheres and Sphere Launchers

- *PyroShot Model FBS-1 Delayed Ground Ignition Device Launcher Operator's Manual*, available at <<http://helifire.com/files/FBS1OPS.pdf>>.

### Terra Torches

- *Interagency Standards for Fire and Fire Aviation Operations, NFES 2724*, available at <[http://www.nifc.gov/policies/pol\\_ref\\_redbook.html](http://www.nifc.gov/policies/pol_ref_redbook.html)>.
- *29 CFR 1910*, available at <<http://www.osha.gov>>. (Search for 29 CFR 1910.)
- *Forest Service Handbook, FSH 7109.19, 31.3*, available at <[https://www.fs.usda.gov/cgi-bin/Directives/get\\_dirs/fsh?7109.19](https://www.fs.usda.gov/cgi-bin/Directives/get_dirs/fsh?7109.19)>.
- Phos-Chek Web site at <<http://phoschek.com>>.

## Transporting Gasoline, Mixed Gas, Drip-Torch Fuel, and Diesel

- *NWCG Standards for Transporting Fuel*, PMS 442, available at <http://www.nwcg.gov/publications/442>.

### Additional Useful References

- *National Fire Equipment System Catalog, Part 1: Fire Supplies and Equipment*, PMS 449-1, available at <http://www.nwcg.gov/publications/449-1>.
- *Interagency Prescribed Fire Planning and Implementation Procedures Guide*, PMS 484, available at <http://www.nwcg.gov/publications/484>.

The *NWCG Standards for Ground Ignition Equipment* is developed and maintained by the Ground Ignition Subcommittee (GISC), under the direction of the Equipment Technology Committee (ETC), an entity of the National Wildfire Coordinating Group (NWCG).

Previous edition: 2011.

While they may still contain current or useful information, previous editions are obsolete. The user of this information is responsible for confirming that they have the most up-to-date version. NWCG is the sole source for the publication.

This publication is available electronically at <https://www.nwcg.gov/publications/443>.

Comments, questions, and recommendations shall be submitted to the appropriate agency program manager assigned to the GISC. View the complete roster at <https://www.nwcg.gov/committees/ground-ignition.subcommittee/roster>.

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