

Apache-Sitgreaves National Forests
Blacklining Accident Assessment
Lessons Learned
4/26/2007

Background:

The Pigeon Prescribed burn, a large 22,000 acre landscape treatment involving both hand and aerial ignition, is planned to occur during 2 main phases. Black lining of several miles of holding line, mostly by hand, was planned and implemented during the middle of April, 2007. On the second day of operations, a member of the prescribed burn team was burned on the leg when his nomex pants caught on fire during blackline operations on an assigned burn block. The injured fireman was transported to the closest Medical Center by vehicle, and immediately flown to the nearest Burn Center for assessment and treatment.

Factual Time Line:

Date: 4/18/07

- 0800 - Morning briefing with all prescribed fire personnel conducted at ICP.
- 1100 - Confirmed lookouts and location of burn out operations Block A
- 1100 – Weather briefing provided for Block A
- 1130-1145 – Burning ops begins in Block A as planned.
- 1200 – Lookout confirms with all personnel on section of Block A burning ops proceeding as planned.
- 1215- Fireman declares to Lookout he has caught fire. Lookout affirms radio contact with fireman.
- 1220 – Fireman declares to Lookout fire is extinguished, moves out of the area for pickup
- 1245-1300 – Fireman arrives at ICP ; Log. and doc. personnel assist in initial treatment; fireman transported for further assessment and treatment.
- 1400 – Injured fireman arrives in town and flown to nearest Burn Center

Overall Safety Elements Incorporated into Burning Operations:

The following overall key elements were developed for Pigeon Prescribed burn operations and were available to all personnel involved with the project:

- *Reviewed and Approved Burn Plan and Aviation Plan
- * Incident Action Plan (IAP) including but not limited to:
 - Communications Plan
 - JHA for burn operations
 - Medical plan with medical emergency procedures and coordinates, and frequency for contact, and assigned EMT's.
 - Short and long range weather forecasts
- * Detailed Maps – specific Burn Blocks, overview map with contingency lines and values at risk.

Daily morning briefings were provided by the RxM1 and RxB2 (B1 t), attended by all personnel involved with the Pigeon prescribed burn. Briefings contained the following key elements:

- *Review and confirmation of burn organization.
- *Burn progress and objectives
- *Burn block assignments
- *Safety concerns/issues and JHA
- *Medical plan and emergency procedures
- *Fire weather forecast

Operational Safety Precautions:

Use of the drip torch for firing is a common practice, and often includes rugged, isolated terrain where more than one torch canister is carried by a lighter to enable effective and safe burning operations where vehicle access is very limited. Carrying a full torch canister, and subsequently a potentially empty canister during burning operations, poses some very specific safety concerns with potential leakage

During late fall and early winter small scale burn operations, District fire management personnel observed what appeared to be abnormal or undue leakage from filled and empty torch canisters. During early winter IA Foreman and second year assistant inspected and replaced o-rings where needed on old and new torch canisters, particularly the rings around breather screws on the side and rings on the larger torch wick plug on top. Rubber gaskets were inspected and replaced as needed on lid tops as well. The inspection also included newly purchased torch canisters that have a slightly different style for the wick plug.

In preparation for development and completion of the Prescribed Fire Complexity Rating Worksheet, a project related Job Hazard Analysis (JHA) was prepared by District FMO on 3/23/2007. Following final burn plan review and amendments, the District Ranger reviewed and approved the Burn Plan and project specific JHA for the Pigeon burn the morning of 4/16/07. The JHA has a specific section on "Use of Driptorch", identifying hazards related to chemical spills and burns.

Accident Narrative:

Initial test burning was conducted the evening of 4/16/07 on a section of line along a road in Block B of the project area. Safety and tactical briefings were conducted with forces by the Burn Boss at the administrative site, and again prior to initial test burn operations.

With successful completion of initial black lining along the west edge of Block B on 4/17, burning operations were to be expanded to include small portions of Block A along the northern perimeter. This section had been scouted the evening before, identifying options for black lining to protect riparian and historic campground values at risk. Morning strategy briefing on 4/18 covered this planned activity and assignments. Individual was assigned to black line the northwest portion of Block A (about ¾ mile of line), as RXI2 (t), along with Engine module of 3, and a line qualified resource advisor from the Fish and Wildlife Service. Discussions took place on the section of line the

evening before, along with Burn Boss Lever. The Fire Manager, was to scout additional portions of Block A, including the main northern perimeter line of Block A, eventually tying back into burn operations to be conducted.

The Resource advisor was to accompany during burning operations in his small section of line, a location where burning activities were visible. During the ½ mile hike into the line location, the resource advisor became concerned about continuing on (aggravating blisters) and was returned to a Highway overlook location where firing activity could be observed and documented, and radio contact could be maintained. The Line scout completed initial line confirmation and location in Block A about 10:30, made contact by radio to confirm location and walked into line area, visiting briefly with the crew who was initially positioned in the canyon bottom. After discussing weather conditions and plans, it was agreed that the Fire Manager would stay on site and hike up to an adjacent rocky outcrop to remain in place as a lookout throughout burning operations. With favorable weather ops obtained and transmitted at 1100, and with the lookout in place, burning operations commenced by about 1130-1145.

Blacklining operations proceeded well from this time through about 1200. The engine module had almost completed their 3/8 mile section with good results, while other burnout was completed and successful on the ridge top and movement had started down a very steep slope, selecting this route as a means of obtaining a larger black line area, and where there was ample fuels of bear grass and bull grass that would carry fire to create an effective blackline. By the time individual had left the ridge top area, he had used an entire drip torch canister of fuel and apparently switched to a second torch.

Black line operations conducted by engine crew and ignitions were entirely in view of Fire Manager. As individual progressed down slope firing, Fire Manager discussed with him what appeared the best route, given rock outcrops and pockets of fuels. Winds were very favorable, light and upslope, carrying fire quickly away from the lighter. The individual was carrying the empty torch in his left hand and lighting with the other torch on the uphill side. About 1215, he called the Fire Manager to say he was on fire. The Fire Manager observed what appeared to be a flash fire around him, who was actually away from any area he had recently fired. The individual struggled to contain the fire around and on his left leg, discarding the empty torch canister in the process which apparently rolled away from him. About 2-3 minutes transpired before he could extinguish the flames, when he contacted the Fire Manager by radio to say the fire was out and he was ok, proceeding down to the drainage. The Fire Manager was in radio contact with the burned individual continually, ensuring that he could move unassisted, and was headed back for pickup. The Fire Manager was contacted by the individual when he reached the initial road and again when he reached the road where he was picked up. He was immediately transported back to ICP where his injuries were assessed and mitigated by the individual since he is a qualified EMT.

About 1315 he was immediately transported to town by vehicle, where the on-scene EMT recommended he be transported by helicopter to the nearest Burn Center.

Apparent Cause and Status of Injuries:

The individual was wearing proper PPE during burn operations, including gloves, nomex pants and boots, all of which reduced burn injuries to his left leg and hands. During his attempt to extinguish the fire on his leg and pants, he did sustain some light to second degree burns to one hand. He sustained a severe third degree burn, about the size of a fist or hand, to his left calf, and second degree burns around the calf to his knee. His boots prevented any burn injuries to his lower leg and foot, and the nomex pants clearly prevented additional burns to the remainder of his leg, especially where the leg pocket provided double layer protection.

The empty torch was apparently leaking and/or spitting fuel on his left leg. The flashy nature of the fire that ignited around the torch canister and his leg, and the extent of burn inside the pant leg itself indicate the fuel was more vaporized gasoline than the normal drip torch mix which does not ignite in a flashy manner. This would have explained perhaps the flashy ignition. Some saturation of burn fuel and apparently trapped gas vapors inside the pant leg may have resulted in the 3rd degree burn area. It is apparent that the vaporized fuel between the torch and the pant leg somehow ignited which in turn ignited his pant leg and the top of the empty torch at the same time.

In addition, a District map covered in laminate plastic, folded and carried in his left lower pants pocket, had slightly melted, contributing to another burn area along his left thigh.

Initial Accident Assessment and Contributing Factors:

On site accident assessment was conducted by the District Ranger, FMO, and crew foreman, using several avenues of obtaining information, including discussions with the individual, observations during the incident, and among District personnel and physicians who assisted the injured fireman before and during transport to the burn center. The most key element in the assessment was retrieval and inspection of the empty torch canister from the accident location.

As in many instances when a drip torch is emptied, it is not completely empty as some residue or fuel mix is left inside. The empty torch that was carried has about ½ inch of fuel mix remaining, and without extensive testing, it is difficult to discern if the mix was made with more percentage of gas than diesel, a mix that could possibly volatize more readily. The individual stated that both torches were burning hotter than a normal mixture.

It appears the wick plug was properly inserted into the top and tightened enough to effectively close the wick. It is not known whether or not the seal was effective due to the melting created from the fire. The “o” ring was completely intact other than being melted and flattened, which indicates that the wick cap was securely fastened. It appeared to be squished out of one side which is common of “o” rings on drip torch cans. This could have been the source of the leaking fuel. When another individual carried the torch out it had began to leak from the wick cap and not the breather screw.

The air breather screw found on the top side of the torch canister, however, was open about ¼ turn when located, and confirmed by the District Ranger later at the office. In a subsequent discussion, the individual stated that he had not tightened the breather screw. Leaving this breather screw open, or if leaking because of a faulty o-ring, can result in leakage of fuel mix in a fuel torch canister. In the case of an “empty” torch, leakage is usually minimal. However, an “empty” torch with a loosened breather screw, especially one being carried where the sunlight hits directly onto the canister, may heat and subsequently result in concentrated gas vapors spewing from the breather screw or the wick cap. Closing the torch lid, inserting and closing the wick plug, and forgetting the breather screw on an “empty” torch commonly occurs. A person completely engrossed in firing activities, especially in steeper terrain where maneuvering is difficult at best, could easily not now realize that volatilization was occurring because that person may not notice or feel the accumulation of the vapors on fabric. In this case, the individual admittedly did not realize that the torch was leaking.

Lessons Learned and Potential Action Items:

1. ***Accidents can happen to experienced, qualified personnel*** – As a trained EMT, and a very qualified and experienced lighter, the individual has demonstrated clearly in practice and preparation the potential safety issues with leakage from torch canisters. The combination of firing in steeper terrain, an “empty” canister containing a minimal amount of fuel mix, concentrated sun heating on a hand carried torch canister, a breather valve that allowed volatilized gases to escape and accumulate on PPE, and a possibly leaking wick cap was outside the slide tray of experience.
2. ***Ensure that JHA’s fully cover potential for leakage and volatilizing fuel mix, not just leakage from full bottles*** – The project JHA has a distinct section on Drip Torch use and potential hazards, and spills. The potential for volatilizing with empty torches, or mitigation to ensure purging is complete, should be added. This is especially important during operations in terrain and weather conditions where radiant sunlight has the potential to create super heated canisters that may leak or bleed gas vapor.
3. ***Develop and Implement a Purging process or protocol*** – During firing operations, especially in rougher terrain not accessible by vehicle, lighters often elect to use a “full” torch to minimize exposure during lighting operations and increase efficiency to complete a line section. Partially filled or “empty” torch canisters are often carried by hand, or backpacked. Leakage remains an issue.
 - a. Adopting a standard policy of completely emptying canisters and burning residual fuel within black lined perimeters could reduce the potential for leakage or volatilizing of gases.
 - b. Adding a purging fluid to an emptied canister would reduce volatilizing.
 - c. Where a torch is partially full (1/4-1/3), and fuel mix is to be preserved, consider using a protective shroud cover that may reduce or contain leakage during transport and continued firing activity.

4. ***Inspect and ensure proper use of torch equipment*** – Inspect “o” rings for all torches on an annual basis, or if used extensively, more regularly. Ensure that lighters are aware that over tightening of canister heads and wick plugs can “flatten” the o-ring, and may result in leakage of fuel mix or vapors both during transport and use on the line. Realize that the new torch wick plug on top of the canister has been re-designed to allow tightening of the plug, potentially resulting in flattened o-rings. While not specifically a design flaw, this is likely the reason District fire personnel have observed what appeared to be more leakage from new canisters.

5. ***Consider alternative lighting equipment in more isolated, rougher terrain*** – Discontinuous fuels and/or fuel moisture conditions optimum for black line operations often does not contribute to the use of other options for firing, except the hand drip torch. Fusees, another commonly used firing apparatus, can be effective when fine fuel density and moisture conditions allow for relatively easy lighting. Use of “Hotshot” flares can be effective to reduce exposure in steep terrain, but requires continuous fuel arrangement for efficient ignition, may be limited in distance available for coverage, and can be very costly. Use of propane burners may be applicable in grassland fuels when fuel moistures are optimum (little greenup and low RH’s), but refilling tanks can be problematic in remote areas and without proper equipment.

6. ***Challenge drip torch makers to design a more effective seal -***

The Gasket seat on the wick cap does not prevent the gasket/O-ring from being pushed out of the area where it is designed to stay. An inward bevel on the gasket seat would promote a more stable surface for the gasket to stay in and ensure a proper seal. A larger seal on both the vent cap and wick cap may help in durability and strength in the seal itself. Further evaluation of all drip torch designs should be explored as a serious safety concern.

District Ranger