Saddle Prescribed Fire Burn Injury
Lessons Learned

Accident Summary

On October 11, 2012 four Forest Service employees were assigned to continue “black lining” the Saddle Salvage Natural Fuels burn unit (561 acres). The unit was typical of natural fuels units in the area with brush and lodgepole pine blowdown scattered throughout. The objective for the day was to extend the black line, started the previous day, at the top of the unit to secure it in preparation for a forecasted wind event. Up to 40 acres were expected to be accomplished over the two days of burning.

Photo is of the general stand vegetation / condition.

Photo shows condition of area following burn.

The four individuals arrived at the unit around 1000. They filled and quickly inspected drip torches and filled extra fuel jugs (approximately 2.5 gallon capacity) from a batch of torch fuel mix that had been used on a late summer fire suppression event on an adjacent Forest. An unknown quantity of diesel fuel was added to this batch mix prior to fall burning to cap off the batch mixture contained in manufactured external fuel tanks designed for use in pick-up trucks. This torch fuel batch mix was labeled as “Torch fuel”. The same batch of torch fuel was used the previous day without any issues. The burn crew briefed on the day’s objective, made assignments, and then started hiking into the unit at 1015. Two employees, including the Burn Boss, were to continue lighting on the West side of the unit and two employees went to the Northeast corner of the unit. All four employees were to be engaged in ignition operations and each carried a drip torch and a fuel jug (approximately 2.5 gallons) of torch fuel mix.

The two individuals on the Northeast corner began lighting in a staggered formation separated by about 20 feet in elevation and 100 feet horizontally. At about 1220, one of the individuals crawled over some blowdown with his driptorch, felt heat on his pants, and looked down to see that his lower left pant leg was on fire. He attempted to pat out the flames with his hands, but the fire immediately spread to both pant legs. Then, he looked for a place to drop and roll. He

had to cross over blowdown and fell into an opening 50-75 feet from where his pants caught fire. He was able to sit down, remove his pants to his ankles, and smother the flames. He had trouble getting his boots off to allow removal of his pants. In the process he removed one glove (left hand) to facilitate removal of pants and boots.

During the accident, the other crew member on the Northeast side heard his partner yell for help and proceeded in that direction. He couldn't see what was happening but was able to hear his partner, recognized his was in distress and quickly located him. He arrived in a few short minutes and observed the injured crew member sitting with his pants around his ankles. At this time, no flames were observed on the pants. The crew member had obvious burns to both legs and his left hand. It was evident that the individual needed to get to a hospital. The first responder radioed the burn boss that there had been a burn accident. The Burn Boss designated the first responder as the Incident Commander of the burn incident. At 1230, the IC called dispatch to request a ground ambulance and the ALERT helicopter. The burned individual and IC hiked out of the unit to the parking area/helispot on top of the unit which was about 300 yards from the accident site.

The ALERT helicopter identified in the Medical Plan was unavailable. A secondary medical helicopter was contacted and was mobilized to the accident scene. The helicopter arrived at 1330. The injured employee was transported to the nearest trauma hospital and then flown to Harborview burn treatment center in Seattle that same afternoon. The accident victim received 2nd and 3rd degree burns to 20-25% of his body (both legs and left hand). He spent five weeks at Harborview. He is back to work on light duty and a full recovery is expected.

Observations:

- The injured employee does not have a clear recollection of events that occurred before, during, and immediately after the accident. There were no eye witnesses when the accident occurred. His burn partner was in hearing distance, but could not see him.

- During the past 30+ years of prescribed burning on the Forest this is the first burn accident involving hand ignition with a drip torch.

- **Fuel on Pants and the Boots:** Lab analysis of the PPE worn by the injured employee indicated that fuel was present on his pants and boots. Nomex clothing contaminated with torch fuel is flammable even with small amounts of fuel and a low ratio of gas to diesel (1:5 gas to diesel) mixture. The injured employee has no recollection of any fuel spill , drip torch leak, or fuel container malfunction that might have allowed fuel to get on his fire pants. He did indicate that the torch and the fuel container may have rubbed on his legs

the day of the accident and during the previous day (he wore the same fire clothes, for ignition operations, the day before the accident) while he was carrying them. Other employees indicated that small amounts of fuel on clothing were part of normal hand ignition operations when using drip torches.

- **Drip Torch:** The prescribed burn crew performed quick visual inspections of their drip torches prior to use. None of the burn personnel remember specifically checking the torches for leaks or specifically checking the breather valve vent tubes on the torches immediately prior to ignition operations. All drip torches are checked thoroughly prior to the spring and fall burn seasons.

  The drip torch used by the injured employee was not preserved at the scene and was subject to some heating from direct contact with flames after the accident. The torch was not inspected at the accident scene and was prepared for transport (lock ring was removed and tank cover/spout was put back inside the torch) following the accident. MTDC (Missoula Technology and Development Center) analyzed the drip torch. At the time of the MTDC inspection, it was determined that the breather (vent) tube was in the torch but not attached to the breather tube screw. If the breather tube was disconnected from the breather tube screw during use, and the breather screw was open, fuel would drip from the screw. In addition, the cover seal was missing. A missing cover seal could also cause a torch to leak. The vent tube could have come loose after the accident and the cover seal could have burned or been lost when the torch was prepared for transport.

- **Torch Fuel:** Adding gasoline to diesel for torch fuel produces a flammable mixture. All FS authorized torch fuel mixtures can be readily ignited from an ignition source.

  Torch fuel on the district is normally mixed on site from commercially manufactured gasoline and diesel fuel containers installed in the "fuel truck". However, on this burn, the "fuel truck" had one fuel tank with pre-mixed "Torch fuel", rather than diesel, and one fuel tank with straight unleaded gas. Torch fuel was not normally batched mixed into the truck storage tanks. Employees "eyeball" gas/diesel quantities to mix torch fuel into jugs, containers, and/or drip torches.

  The JHA stated "Follow fuel mixture ratio in the Health and Safety Code Handbook". The JHA did not state what the FS authorized mix ratios were. Employees were not all aware of FS authorized torch fuel mixtures. A check of other units on the Forest indicated that authorized torch fuel mix ratios were not used on all units.

A lab analysis of the torch fuel mix (the analyzed torch fuel was not drawn from the injured employees torch, but did come from another torch that was used on the burn unit), was found to be approximately a 1:1 gas/diesel mixture. Employees stated that they did not notice anything unusual about the fuel mix.

- **The fuel jugs used to haul torch fuel in the burn unit were used plastic herbicide containers:** The jug the injured employee was using to carry torch fuel on the day of the accident could not be found and may have burned in the unit. It could not be analyzed to determine if it leaked, was punctured, or if the lid failed.

  Re-using plastic herbicide containers for torch fuel in burn units had become an SOP due to perceived benefits. The JHA stated to use an "approved container". Some employees perceived the jugs to be better/safer/more practical/more efficient for the hauling and dispensing of extra torch fuel in burn units. Several employees commented on the difficulty of carrying safety cans and of problems with them leaking. One employee indicated that he felt the jugs were unsafe but continued to use them. It was not uncommon for jugs to get punctured, for lids to break, or to have a lid that did not fit tightly.

- **Job Hazard Analysis (JHA), Process, and Use:**
  The JHA in use for the burn operation included hazard identification and mitigations for prescribed burning with hand ignition. The JHA included "use only approved fuel containers", "Follow fuel mixture ration in the Health and safety Code Handbook", "Do not spill burn mix on clothing", and "Avoid fuel contact with bare hands, clothing and boots". All employees involved in the prescribed burn on the day of the accident had signed off as having reviewed the JHA. One employee reviewed 20 separate JHAs the first 3 days of work (including the JHA for prescribed burning). It is common practice on the district for employees to review/document numerous JHA's the first several days of work. Tailgate Safety Sessions are used before beginning work activities to review hazards and reinforce/review abatement actions from the JHA.

- **Implementation of Guidance, Rules, and Procedures:** Employees did not perform any procedures that were out of the ordinary for burn operations in place on the unit. All work activities followed standard operating procedures in place on the District with the single exception of having one tank of pre-mixed torch fuel in the "fuel truck" storage tanks. However, some guidance contained in the Health and Safety Code Handbook (and referenced in the JHA) was not followed.

- **Management Reviews:** There has not been a documented prescribed fire field review conducted for the district.

- **Radio Communications:** Direct radio contact could not be made with the individual identified to escort the ground ambulance to the accident scene.

- **Other:** Employees on the burn unit carried FireQuick flares in their Nomex pants pockets. The injured employee had flare rounds in his pants that did not ignite during the burn accident.

What Went Well:

- **Incident IC was established:** The Burn Boss was 20 minutes away from the accident site. He immediately designated the on-site individual as IC for the burn incident.

- **Command and Control:** Individuals involved remained calm and acted decisively. The individual who as burned was able to walk out of the unit. The Burn Boss identified roles and responsibilities. The IC took immediate actions to ensure the injured employee would get to a hospital in a timely manner and developed a contingency plan rather than relying solely on aircraft. The IC took precautions to help the burned individual remain calm. He turned off the burned individual's radio to minimize what he heard; he had conversations with dispatch/burn boss out of earshot of burned individual in a conscious effort to lessen the injured employee's anxiety.

- **First Aid response on-site:** Fellow employees did a good job of wound care using sterile bandages and preventing contamination of the wounds.

- **Communications:** The IC maintained good, clear, concise communication with the other individuals in the unit and with Dispatch. Only necessary information was shared over the radio.

- **Contingency Planning:** Individuals on-site, in the Dispatch Center, and at the home unit did well adapting to changing circumstances. There were two modes of emergency response identified and activated (local ambulance and ALERT) immediately. There was a plan in place for traffic control on narrow logging road with log truck traffic to allow ambulance access as needed. A second helicopter was mobilized when it was determined that the primary aircraft was unavailable. Arrangements were made to have agency personnel meet the injured employee at the hospital and redundancies were built in to ensure the employee was not at the hospital alone.

- **District support to individual and family:** The district got word to injured individual's wife and provided transportation for his wife and child to the trauma center in time for them to fly to Harborview with the patient. Two employees met the patient at the hospital to ensure administrative items were taken care of. The injured employee expressed how grateful that someone he knew was at the hospital to meet when he arrived on the helicopter. Another employee contacted the Wildland Firefighter Foundation and started working with the group to provide resources to the family.

- **Support from the Wildland Firefighters Foundation:** Shortly after arrival at Harborview, the Foundation had already made arrangements to support the injured employee and his family.

- **Learning Analysis Cooperation:** All individuals involved have been cooperative, open in their discussions, and have provided support in helping ensure that others learn from this accident.

Lessons Learned:

- **Ensure employees understand the risk when clothing is contaminated with torch fuel:**
  - Demonstrate the flammability of fuel contaminated Nomex to employees.
  - Employees must understand the need to move away from ignition sources if clothes become contaminated with fuel.
  - Fuel contaminated clothes must be changed prior to reengaging in work activity near flames or any other ignition sources. Individuals should have a change of fire clothes available in case of fuel contamination.
  - Employees performing ignition duties will wear clean Nomex daily to minimize chances of any build-up of flammable material on Nomex.

- **Ensure torches are inspected and work properly prior to use:**
  - Ensure proper procedures are followed when using drip torches. Inspect drip torches prior to use and check for leaks. Torches should be wiped down (disposable wipes, paper towels, dry dirt) after filling so fuel does not rub off on clothes.

- Complete inspection procedures can be found in the Interagency Ground Ignition Guide (2011): http://www.nwcg.gov/var/products/interagency-ground-ignition-guide.

- Fill torches according to manufacturer's recommendation. Do not fill to the top – leave room for expansion. This can help minimize fuel leaking on the torch during transportation, storage, and/or during use.

- **Use Agency authorized torch fuel mixtures for prescribed burning:**
  - For the Forest Service, authorized torch fuel mixtures are: (Health and Safety Code Handbook chapter-page: 20-89).
    - 1 gallon of gas to 3 gallons of diesel = (25% to 75%)
    - 1 gallon of gas to 4 gallons of diesel = (20% to 80%)
    - 1 gallon of gas to 5 gallons of diesel = (16.67% to 83.33%)

  - The following gallons of gas/diesel would be mixed in a 5 gallon can:
    - 1:3 = 1.25 gallons of gas and 3.75 gallons of diesel.
    - 1:4 = 1 gallon of gas and 4 gallons of diesel.
    - 1:5 = .83 gallons of gas and 4.17 gallons of diesel.

  - Use the smallest amount of gasoline in the torch fuel mixture needed to do the job.

  - Develop/utilize tools (mixing instructions, pocket card with table, posted instructions, measuring devices/gauges) that provide information on the amounts of gas and diesel for authorized torch fuel mixtures and for the variety of approved containers being used on the unit.

- **Utilize approved safety containers for incidental storage or use of flammable/combustible Liquids as per FSH 6709.11 (Health and Safety Code Handbook) 61.51d (4)(c).**

- **Preserve accident scenes, equipment, PPE, etc. when possible.**

- **Radio Communications:** Contingency plans for radio communications during emergency situations should be developed. Radio "black holes" should be identified to employees. Radio checks need to be standard procedure. Back-up communications (satellite/cell phone, human repeater) should be made available when possible.

- **Ensure that the JHA process is sufficient to meet the intended objective…to identify safety/health hazards, develop abatement actions for those hazards, and ensure employees understand this information by allowing time for adequate review, discussion, and questions:**
    - JHAs for Rx fire implementation using drip torches should be reviewed and updated, as needed.

    - Key safety items should be included and not just incorporated by reference.

    - Management should work with employees to review how JHAs are developed, reviewed by employees, and implemented to ensure the process is effective.

- **Management must ensure that work activities are being done safely**:
    - Field visits/reviews should be conducted to help ensure that employees are meeting management expectations regarding accepted safe work practices. High risk activities should be identified and prioritized for review. Peer to peer reviews with employees from adjacent units should be considered to help identify work practices that might have more in common with what has been done in the past (SOP's) rather than with the most current safe practices/procedures/Health and Safety Code Handbook guidance/lessons learned/JHAs.

- **Consider establishing protocols that help ensure a Forest representative is available to provide support to injured employees at emergency facilities.**