United States Department of Agriculture
Forest Service

Accident Investigation Report

FIRE SHELTER DEPLOYMENT
I-90 COMPLEX, LOLO NATIONAL FOREST
NORTHERN ROCKIES
MISSOULA, MONTANA

August 10, 2005

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Factual Report

Executive Summary

At approximately 7:00 pm, August 10, 2005, two dozer bosses and one contract dozer operator, assigned to Division M, Tarkio Fire, I-90 Complex, deployed their fire shelters while in a safety zone during an active period of burning around the safety zone. All three firefighters were unharmed during the event.

The Tarkio Fire was one of several fires in the I-90 Complex located on the Ninemile Ranger District, Lolo National Forest. Fires in the I-90 complex were ignited by human cause along an approximately 20 mile stretch of Interstate 90 west of Missoula, Montana on August 4, 2005. A Northern Rockies Type 1 Incident Management Team assumed command on August 5, 2005.

Plans for the day in Division M were to utilize an interagency hotshot crew and dozer to burn-out and improve indirect line. A local inversion broke around mid-day and the fire activity began to increase. At approximately 1600, firefighter resources in Division M were directed to withdraw and move to safety zones. While traveling to the safety zone, the dozer operator and two dozer bosses were alerted by other crews that their primary escape route may be compromised. Following additional communications, the Division Supervisor confirmed to the Dozer Boss that their route had been cut off. The dozer operator and two dozer bosses elected to turn around and return to an alternate safety zone they had previously identified. The alternate safety zone was a combination road junction/switchback. Upon arriving at the alternate safety zone at approximately 1630, they further prepared the area by removing adjacent fuel with the dozer. At approximately 1830, they positioned the dozer in a defensive position near the center of the safety zone with the rear of the dozer facing the direction of the approaching fire. The truck was parked approximately 15 feet in front of the dozer. At approximately 1900, the fire front passed the safety zone. The dozer operator and two dozer bosses crouched in front of the dozer blade initially, and then deployed their fire shelters in the same location to protect themselves from fire embers and heat. By approximately 1910, they were out of their fire shelters, estimating they had actually been in the shelters for approximately two minutes.

One of the dozer bosses notified the hotshot crew superintendent that they had deployed their shelters as the fire front passed. The Division Supervisor, Operations Section Chief, Safety Officer, Emergency Medical Technician, and a Sawyer traveled to the site arriving at approximately 2030 to verify that the three individuals were unharmed and to secure the site. The two Dozer Bosses were transported back to the Incident Command Post and the contract dozer operator traveled to his residence for the night.

The shelters deployed were all new generation fire shelters. There was no visible damage to the dozer or vehicle.

Positive Causal Factors~

- The three firefighter's, supported by and in communication with key incident overhead, chose a known alternate safety zone rather than risk traveling an escape route which may have been compromised. (Conclusions drawn from Witness Statements and Interviews)
- Firefighters were equipped with fire shelters and Personal Protection Equipment and they functioned as designed. (Witness statements and examination by Equipment Specialist)

Negative Causal Factors~

- The time allowed for the dozer to travel to the safety zone was based on fire behavior observed previous days and up to that point, they did not anticipate the fire behavior which actually occurred. Alternatives identified by the Dozer Bosses and Dozer Operator that would have avoided this incident included:
    - Remain at the blackened fire line.
    - Abandon the dozer and take operator to Upper Safety Zone in another vehicle.
    - Send the dozer to the Upper Safety Zone immediately after line improvement was completed.

Findings and additional positive and negative contributing factors are contained in the narrative section of this report.

INCIDENT CHRONOLOGY
SHELTER DEPLOYMENT, I-90 COMPLEX

WEDNESDAY - AUGUST 10, 2005

0700 ~ Day Shift Briefing at Incident Command Post.

0930 ~ Resources arrive at Division M.
- Lookout established across the draw.
- Interagency Hotshot Crew-A Supervisor serves as lookout on line.

1100 ~ Interagency Hotshot Crew-A begins burning out down dozer line.
- Dozer is improving line ahead of Interagency Hotshot Crew-A.

1200 – 1230 ~ Inversion breaks.

1214 ~ Weather update broadcasted.

1300 ~ Slopover from previous day at the Division L/M Break is becoming active.

1305 ~ Interagency Hotshot Crew-A holds up burn while Dozer establishes safety zone near bottom of dozer line above the 35/73 road.

1315 ~ Dozer completes improvement of dozer line down to the 35/73 road.
- Dozer Boss-B moves from staging at the Division H/M break to Dozer Boss-A's location.

1345 ~ Interagency Hotshot Crew-A completes burnout operation.
- Burn out is 200-300 feet deep and backing into the draw.
- Dozer Bosses-A & B and Dozer Operator eat lunch on 35/73 Road at the bottom of the dozer line.

1400 ~ Helicopter delivers first bucket to slopover at the Division L/M break.

1430 – Spot develops near line being held by Interagency Hotshot Crew-C.

1430 – 1500 ~ Slopover becomes more active, burning up an adjacent draw.

1438 ~ Weather update: All units acknowledged except Division-M, Division-H, and Division-K.
- Dozer Bosses-A & B copied weather update.

1506 ~ Well developed plume from slop-over visible to Interagency Hotshot Crew-D in Division C.

1515 ~ Dozer Bosses-A & B and Dozer Operator meet with Operations Section Chief-A and Safety Officer-A approximately one mile up from dozer line on 35/73 Road; discussed fire activity, escape routes and safety zones.

1530 ~ Dozer Operator moves dozer approximately 1 mile up the 35/73 road to Dozer Boss-A's location. Dozer Boss-A was posted as a lookout for Interagency Hotshot Crew.

- Slop-over on north ridgeline is well established and moving toward power line.
- Operations Section Chief-A and Safety Officer-A drive up the escape route to check Upper Safety Zone.

1545 ~ Spot detected below 35/73 Road, inside the contingency line.

1600 - 1605 ~ Dozer Boss-A identifies a spot on the green side of dozer line and directs two firefighters from Interagency Hotshot Crew-A to the spot above the road.

- Safety Officer-A and Operations Section Chief-A return to dozer location. Safety Officer-A, Operations Section Chief-A, and Division-M are in communication regarding the situation.
- Division-M orders all resources to their safety zones.
- Division-M orders slopover resources to Drop Point-22, with Task Force Leader-A in charge of those resources.
- Dozer Boss-A diverts helicopter to work the spot fire below 35/73 road outside of the line.
- Dozer Boss-A tells Division-M he would like to put one more load of water on the spot fire before proceeding towards the Upper Safety Zone.
- Dozer Boss-A requests helicopter to load and return; it never returns.
- Dozer Bosses-A & B and Dozer exit the area toward the Upper Safety Zone.
- Spot develops on Road 9904 across the drainage.
- Egress out the 35/73 road is cut off around 1600.

1615 – Interagency Hotshot Crew-A Supervisor informs firefighters that road to Upper Safety Zone may be compromised.

- Safety Officer-A, Operations Section Chief-A and Division-M make it to the Upper Safety Zone before fire cuts off their egress.
- Division-M informed Dozer Boss-A that the road to the Upper Safety Zone has been cut off. He also advises that the alternate escape route (36 Road) may be compromised by fire activity from Division H.
- Dozer and Dozer Bosses-A & B turn around and proceed to large switch back they had previously identified as an alternate safety zone at the junction of the 35/73 & 9917 road.

1620 ~ Dozer Bosses-A & B and Dozer arrive at alternate safety zone.

- The dozer goes to work to improve the safety zone.

1630 ~ Resources assigned on Division L (including Interagency Hotshot Crew-C) use escape route to return to Drop Point 22.

1640 ~ Work to improve the alternate safety zone is completed by the dozer.

1705 ~ Operations Section Chief-A reports long range spotting in Division M.

1730 ~ Operations Section Chief-A and Branch discuss returning to work on slopover; Branch advises that the area is too dangerous to work.

1800 ~ Fire is established in drainage bottom below alternate safety zone.

1830 ~ The dozer is placed into defensive position.

- Sustained crown runs are visible across canyon.

- Dozer Bosses-A & B and Dozer operator removed personal gear from pick-up bed to prevent the truck from burning.

1850 ~ Fire is on north side of the drainage, parallel to the alternate safety zone; fire is moving up drainage.
- Dozer Bosses-A & B and Dozer operator crouch in front of dozer blade.

1900 ~ Flames extend to 20 feet over head of firefighters.
- Dozer Boss-A gives order to deploy shelters.

1910 ~ All three firefighters are out of their shelters; time in shelter is several minutes.

1918 ~ Dozer Boss-A called Interagency Hotshot Crew-A Supervisor; advises him that they deployed fire shelters and there are no injuries.

1920 – 1930 ~ Dozer Bosses-A & B and Dozer Operator start to document incident.

2030 ~ Division-M, Operations Section Chief-A, Safety Officer-A, and 2 members of Interagency Hotshot Crew-B (1- Emergency Medical Technician, & 1 Sawyer) arrive at deployment site at alternate safety zone.

- 2130 ~ Division-M, Operations Section Chief-A, Safety Officer-A, Dozer Bosses-A & B, and Dozer Operator return to Upper Safety Zone and conduct an After Action Review (AAR) with all involved resources; after AAR they depart for Drop Point-22.

- 2315 ~ Division-M, Operations Section Chief-A, Safety Officer-A, Dozer Bosses-A & B, and Dozer Operator arrive at Drop Point-22.
- Dozer Operator returns to his home.
- Dozer Bosses-A & B return to Incident Command Post.

THURSDAY – AUGUST 11, 2005

0130 ~ Dozer Bosses-A & B arrive at Incident Command Post and are seen by Medical Unit.

FINDINGS

Human ~

- Lookouts, Communications, Escape Routes, and Safety Zones (LCES) was an operational principle guiding suppression operations. (Conclusions drawn from Statements and Interviews)

- Personnel were qualified for positions held. (Red Card Qualifications documentation)

- Dozer Bosses and Dozer Operator were trained in the use of New Generation Fire Shelters. (Statements from individuals involved)

- Leaders expressed clear, concise intent to ensure assignments were managed safely, effectively, and efficiently. (IAP and Witness Statements)
    - Suppression operations were conducted within appropriate span of control.
    - Fatigue was managed appropriately.

- Subordinate commanders made decisions on their own initiative, based on their leader's intent, coordinated efforts and operational objectives. (Witness Statements)

- The time allowed for the dozer to travel to the safety zone was based on fire behavior observed previous days and up to that point, they did not anticipate the fire behavior which actually occurred. Alternatives identified by the Dozer Bosses and Dozer Operator that would have avoided this incident included:
    - Remain at the blackened fire line.
    - Abandon the dozer and take operator to Upper Safety Zone in another vehicle.
    - Send the dozer to the Upper Safety Zone immediately after line improvement was completed.

- A weather update for 1500, predicting an incremental increase in wind, was never delivered to Communications. (Statement from Incident Meteorologist)

- Firefighters maintained situational awareness and while underestimating rate of change, they were resilient, recognizing changing conditions and executed accordingly. (Witness Statements and Interviews)

- The three firefighter's, supported by and in communication with key incident overhead, chose a known alternate safety zone rather than risk traveling an escape route which may have been compromised. (Conclusions drawn from Witness Statements and Interviews)

- Firefighters used two hours of discretionary time to improve their situation prior to the arrival of the fire front: (Dozer Boss Statements)
    - Removed personal gear from the pick-up rather than risk damage to expensive equipment.
    - Aligned equipment for maximum protection.
    - Enlarged and removed fuel from safety zone.
    - Staged water and fireline packs with shelters.
    - Removed fusees from packs and isolated them in a safe location.
    - Communicated with incident personnel.

Environmental ~

- Fire behavior transitioned from inactive to active to extreme. (Weather reports, Statements, Photographs, Fire behavior observations)
    - The initial weather report was updated at 1214 and again at 1438, indicating weather conditions were changing from forecasted conditions.

Material ~

- Firefighters were equipped with New Generation Fire Shelters and Personal Protection Equipment that functioned as designed. (Witness statements and examination by Equipment Specialist)

POSITIVE CAUSAL FACTORS ~

- The three firefighter's, supported by and in communication with key incident overhead, chose a known alternate safety zone rather than risk traveling an escape route which may have been compromised. (Conclusions drawn from Witness Statements and Interviews)
- Firefighters were equipped with fire shelters and Personal Protection Equipment and they functioned as designed. (Witness statements and examination by Equipment Specialist)

NEGATIVE CAUSAL FACTORS ~

- The time allowed for the dozer to travel to the safety zone was based on fire behavior observed previous days and up to that point, they did not anticipate the fire behavior which actually occurred. Alternatives identified by the Dozer Bosses and Dozer Operator that would have avoided this incident included:
    - Remain at the blackened fire line.
    - Abandon the dozer and take operator to Upper Safety Zone in another vehicle.
    - Send the dozer to the Upper Safety Zone immediately after line improvement was completed.

POSITIVE CONTRIBUTING FACTORS ~

- Lookouts, Communications, Escape Routes, and Safety Zones (LCES) was an operational principle guiding suppression operations. (Conclusions drawn from Statements and Interviews)
- Personnel were qualified for positions held. (Red Card Qualifications documentation)
- Dozer Bosses and Dozer Operator were trained in the use of fire shelters. (Statements from individuals)
- Leaders expressed clear, concise intent to ensure assignments were managed safely, effectively, and efficiently. (IAP and Witness Statements)
    - Operations conducted within normal span of control.
    - Fatigue was managed appropriately.
- Subordinate commanders made decisions on their own initiative, based on their leader's intent, coordinated efforts and operational objectives. (Witness Statements)
- Firefighters maintained situational awareness and while underestimating rate of change, they were resilient, recognizing changing conditions and executed accordingly. (Witness Statements and Interviews)
- Firefighters used two hours of discretionary time to improve their situation prior to the arrival of the fire front: (Witness Statements and Investigation Conclusions)
    - Removed personal gear from the pick-up rather than risk damage to expensive equipment.
    - Aligned equipment for maximum protection.
    - Enlarged and removed fuel from safety zone.
    - Staged water and Fireline packs with shelters.
    - Removed fusees from packs and isolated them in a safe location.
    - Communicated with incident personnel.

NEGATIVE CONTRIBUTING FACTORS ~

- Fire behavior transitioned from inactive to active to extreme. (Weather reports, Statements, Photographs, Fire behavior observations)
    - The initial weather report was updated at 1214 and again at 1438, indicating weather conditions were changing from forecasted conditions.
    - An additional weather update, initiated at approximately 1500 and completed by approximately 1600, was never delivered to Communications. Because increased wind was already being experienced at the time the update was completed, it is difficult to ascertain whether the failure to deliver this update to Communications was contributory or not.

APPENDIX - A

STANDARD FIREFIGHTING ORDERS

FIRE BEHAVIOR

- Keep informed on fire weather conditions and forecast.
    - Briefings included fire weather forecasts.
    - Updates were communicated to line personnel with the exception of the 1600 update.

- Know what your fire is doing at all times.
    - Lookouts were posted.
    - Information about fire status was shared between adjacent forces.

- Base all action on current and expected behavior of the fire.
    - Actions and decisions were based on expected fire behavior, however actual fire behavior exceeded expectations of the individuals involved in the shelter deployment.

FIRELINE SAFETY

- Identify Escape routes and safety zones and make them known.
    - Multiple escape routes and safety zones were identified and communicated, however actual intensity and spread rates exceeded predicted fire behavior, making identified escape routes inadequate.

- Post Lookouts when there is possible danger.
    - Multiple effective lookouts were posted.

- Be alert. Keep calm. Think clearly. Act decisively.
    - All resources remained mentally engaged focusing on the challenges at hand. Actions were decisive.

ORGANIZATIONAL CONTROL

- Maintain prompt communication with your forces, your supervisor and adjoining forces.
    - Supervisors were engaged and on site. Suppression forces achieved cooperative and timely communications.
    - Radio communication networks were established and functioned well.

- Give clear instructions and insure they are understood.
    - Commander's intent and instructions were clear and understood.

- Maintain control of your forces at all times.
    - Span of control was within normal limits and all supervisors maintained control of their resources.

- Fight fire aggressively having provided for safety first.

- Standard mitigations were in place however escape route timing to the Upper Safety Zone for the dozer was based on fire behavior observed in prior operational periods.

EIGHTEEN WATCHOUT SITUATIONS

- Fire not scouted and sized up.
  - Fire was scouted and sized up.

- In country not seen in daylight.
  - Fire operations were being conducted in daylight conditions.

- Safety zones and escape route not identified.
  - Multiply safety zones and multiple escape routes were identified.

- Unfamiliar with local factors influencing fire behavior.
  - Briefings and fire behavior updates communicated local factors. All firefighter had experience fighting fire in timber fuel types.

- Uninformed on strategy, tactics, and hazards.
  - Commander's intent including strategy, tactics and safety concerns were communicated at morning briefings listed in IAP and discussed throughout the operational period.

- Instruction and assignments not clear.
  - Commander's intent, instructions and assignments were clear to all resources.

- No communication link with crew member or supervisor.
  - Communications were established and effective.

- Constructing line without safe anchor point.
  - The dozer line was anchored to the hard black at the Upper Safety Zone.
  - The slop-over at the bottom of Division M was not yet anchored. Resources assigned to slop-over were developing a plan to secure the slop-over.

- Building fireline downhill with fire below.
  - Downhill line construction was mitigated with LCES.

- Attempting frontal assault on fire.
  - In general this fire was being managed with a combination of direct and indirect tactics for the entire fire perimeter.
  - LCES was in place as a standard mitigation.
  - Interagency Hotshot Crew-A and the dozer were at the head of the fire improving downhill fireline, bringing fire with them as they progressed. This operation was completed at 1300.

- Unburned fuel between you and fire.

    - When the dozer left the protection of the anchored and burned out fireline and proceeded up the 35/73 road, the amount of unburned fuel between them and the fire increased.

- Can not see main fire; not in contact with someone who can.
    - Lookouts were in place to provide information on fire status.

- On a hillside where rolling material can ignite fuel below.
    - Dozer line was established parallel to the slope to minimize rolling materials and avoid doglegs. Patrolling by crews and the use of established lookouts helped discover rollout across the roads used as fireline.

- Weather becoming hotter and drier.
    - Weather was becoming hotter and drier. Weather updates were issued and crews monitored this through personal observation.

- Wind increases and/or changes direction.
    - Wind was increasing and coming into alignment with the South Fork of the Nemote drainage. Weather updates were issued and crews monitored this through personal observation.

- Getting frequent spots across line.
    - As the fire became active frequent spots contributed to rapid fire growth.

- Terrain and fuels make escape to safety zones difficult.
    - The decision to take the dozer up the road to the Upper Safety Zone was based on the fact the dozer could not climb the last few yards at the top of the dozer line leading to the Upper Safety Zone.
    - Steep terrain with switchback roads resulted in a long travel time for the dozer to get to the Upper Safety Zone.

- Taking a nap near Fireline.
    - This was not an issue on this operation.

APPENDIX - B

FIRE BEHAVIOR FORECAST
Bobby J. Shindelar, FBAN

WEATHER SUMMARY ~

Wednesday, August 10, 2005 - A weak low pressure system along the Canadian and Montana border will produce mainly west winds aloft. Winds aloft at 10000 to 15000 feet are 10-20 knots and will mix to the surface again due to daytime heating. The inversion will not be as strong as this past weekend and will lift in the late morning. Fire activity could begin early in the day due to better mixing winds and a weaker inversion. Temperatures will be slightly cooler, but not significant, about 85-90. Minimum relative humidities have been in the mid teens in the late afternoon and should climb to the upper teens as there will be a bit more moisture available at mid levels due to the trough. There is a 10% chance of a late afternoon shower or thunderstorm.

The predominate valleys or canyons are narrow and oriented southwest to northeast. Wind direction will be lined up well for channeling to occur in these valleys and canyons. Winds in the deeper canyons can be 5-10 mph stronger with RHs 5% lower.

Expect mainly light upslope winds, 2-4 mph through the morning hours and more up-valley winds of 4-8 mph with gusts to 10-15 mph. **Again the favored channeled areas will see more winds. These west to southwest winds are favorable for channeling and funneling of winds over this I-90 fire.**

SPECIFIC ~

Tarkio Fire: The head of the fire is active along the northwest and north aspects and on top of the southwest to northeast ridgeline directly above and south, along the South Fork of Nemote Creek. The South Fork of the Nemote Creek runs to the northeast continuing under the BPA power lines, approximately 2 1/2 miles from the head of the current fire location.

The lower 1/3 of the slope is made up of open pine stands with a grass understory and light to moderate activity slash from logging. The upper 2/3 of the slope on the north and northwest aspects and the ridgeline is sparse with timber but has a heavy grass component with light to moderate activity slash from logging operations for the first mile. Periodic Ponderosa Pine and Lodgepole Pine stringers, within riparian areas, are running from the top of the ridge down to the bottom of the drainage within the first mile.

After the first mile upvalley, a heavy mix of timber types begins from the bottom of the drainage to the upper 2/3 of the slope for the next mile. The upper 1/3 of the slope is mostly grass with moderate slash and a significant amount of dead and down snags from a previous fire in 2003.

A 1/2 mile south of the BPA power line, the West Fork of Nemote Creek bends north and splits into two narrow and very steep canyons leading up to the power lines. At this point, the timber is at its heaviest concentrations on both sides of the drainage. The lower 2/3 of the slope is mixed aged and mature Ponderosa Pine with a grass understory on west, southwest, and south aspects. The upper 1/3 of the slope transitions to stands of mixed Ponderosa Pine with thick stands of Lodgepole Pine with bug kill. These stands continue underneath the power lines and beyond to the north.

Directly across the valley from the current fire location, on southerly aspects, the lower 2/3 of the slope is mixed aged and mature Ponderosa Pine with a grass understory on west, southwest, and south aspects. The upper 1/3 of the slope transitions to stands of mixed Ponderosa Pine with thick stands of Lodgepole Pine with bug kill. These stands continue underneath the power lines and beyond to the north.

Probability of ignition will be between 80 and 100% each day during the daytime burning periods. On southerly aspects, flame lengths in open Ponderosa Pine stands with grass understory will be between 7 to 10 feet with rates of spread at 40 to 60 chains per hour. Areas with grass and light to moderate logging slash will have flame lengths between 4 and 6 feet with rates of spread from 15 to 20 chains per hour. When the fire reaches the bend in the canyon to the north a 1/2 mile south of the powerline, flame lengths will be 6 to 9 feet with rates of spread from 30 to 50 chains per hour in the Lodgepole Pine. An active crown fire will occur when the fire reaches this point. Flame lengths will be 100 to 150 feet.

The fire will be impacted primarily by upvalley and up slope winds. The fire will continue to spread evenly upvalley on the northern aspects within the West Fork of Nemote Creek. Along the ridgeline south of the West Fork of Nemote Creek, the fire will spread following the ridgeline at a faster rate due to exposure to the wind and lighter flashy fuels.

Spot fires are likely to occur upvalley and up slope at distances between 200 and 500 feet. As the column rises above the protection of the ridgeline to the south, the free flowing winds from the southerly directions will bend the column to the north and northeast. There is a strong probability that fire will spot up to a 1/4 mile across the valley to the north. Spot fires will grow rapidly and exceed suppression capability within 30 minutes of detection if no action is taken on them. If a spot fire gains momentum across the West Fork of Nemote Creek, a significant increase in rates of spread from both sides of the valley will occur and they will combine as one. When fire is established on the north side of the valley, upslope runs will create spot fires up to 1 mile, into Sheridan Creek drainage to the north.

Depending on the amount of spot fires and their placement, it is anticipated that the main fire will spread to the northeast (two miles), within two to three days, at the bend in the valley to the north (point 1). From this point, the fire will spread to the north and reach the power lines within 3 to 4 hours. The power line that crosses the west canyon (point 2), will be impacted by the fire first and then shortly after the section of power line that crosses the canyon to the east (point 3), will be impacted. The lines will be hit with a significant amount of heat and smoke.

FIRE BEHAVIOR SUMMARY
Tami Parkinson - FBAN
AUGUST 5-17, 2005

The I-90 complex includes the Alberton East, Fish, Tarkio and West Mountain fires. The fires were detected on August 4, 2005; it is uncertain at this time what actually started this group of fires. Initial attack activity was taken on the fires immediately; these actions were concentrated in areas with urban interface. Active fire behavior was exhibited early on and escaped initial attack efforts on the West Mountain and Tarkio fires.

The following document is a general report discussing fuels, weather and topography and how these affected fire behavior within the I-90 Fire Complex.

Fuels ~

A variety of fuel models were represented throughout the fire area, including FM 1, FM 2, FM 8, FM 10 and FM 11. A fuel model 1 best represented the grass component found within the West Nemote fire perimeter from the 2000 fire season. The grass was patchy and somewhat discontinuous as you reached the northern-most edge of the old burn. The private industrial landowner sprayed this area with herbicides to reduce competition from herbaceous vegetation within plantations.

A FM 2 best represents the fuel component on the lower elevations and south facing slopes beneath the Ponderosa Pine overstory. Douglas-fir encroachment and brush with needle drape provided ladder fuels for fire to become established within the crowns.

A FM 8 best represented the fuels found at higher elevations (Division O, R) as the types changed to a more mixed conifer overstory composed of Larch, Douglas-fir, and Lodgepole Pine. The surface fuels included beargrass and some false huckleberry. Mountain pine beetle has taken a significant toll within the lodgepole pine found to the north of Stark Mountain Lookout. The effects of this infestation would be better referred to as an epidemic; the mortality is widespread and continuous. The needles are red and still on the trees but given time, these trees will begin to come down establishing a significant ground fuel component.

A FM 10 represents areas on the northerly aspects, low-mid elevations in Division C and stringers of unmanaged timber within Divisions M, N and R. These stands are decadent in nature; insects and disease have been ongoing; resulting in heavier surface fuel loads.

The private industrial lands found within the original Tarkio Fire were best represented by a FM 11. Fresh logging slash, and old untreated slash played a significant role in the initiation and duration of the fire event. Areas that appeared to have an older overstory also had a residual slash component as a result of intermediate harvesting techniques and minimal slash abatement.

The ground fuels were dry for all size classes, smaller fuels (1, 10, 100 hour) ranged from 3-7% and the 1000 hour fuels were 5-8%. Live fuels measured by local district folks were approximately 90% within the ninebark on August 7. Talking with locals, there are some microsites considerably drier (live fuels 50%). Live fuels are beginning to show signs of stress, colors are beginning to change, leaves are falling or becoming brittle and the berries are starting to dry. The dryness we are seeing in these fuels is attributed to several factors such as the lack of snow pack last winter, ongoing drought conditions, minimal rain throughout the month of July and the current warm and dry air mass. The energy release component for the Lolo National Forest is above the 97th percentile.

There are no natural fuel breaks occurring within close proximity of the fire area. There is a type change as the elevation increases; consisting of a beargrass component beneath a more open stand of Lodgepole Pine and Subalpine Fir. Areas with a closed canopy at the higher elevations are not showing dramatic signs of curing, where more open exposed areas are starting to show signs of changing fuel conditions. When the major run occurred on August 10, the fire hit these fuel type changes in the late evening (2200-2300), the winds had shifted to the northwest and the fire ran out of steam. Had the fire event started earlier in the day, and hit this area with a good head of steam, there is a high probability it would have burned into the dead Lodgepole Pine component along the northwest ridge beyond Stark Mountain Lookout.

Weather ~

Weather conditions played a significant role in the fire behavior of this fire. The snowpack last winter was approximately 40% of normal which has led to abnormally low 1000 hour fuel moistures. The lack of snowfall is also having impacts on the live fuel moistures throughout the northwest; things are starting to show signs of dormancy or a hard frost. The spring was considerably wetter than normal throughout the month of June (+2.71 inches from March-June). This moisture did not compensate for the lack of snowpack; instead it created a heavier fine fuel bed (grasses). Despite the wet spring conditions, western Montana proceeded to dry out quickly with hot and dry weather conditions. There were only two days of measurable precipitations since July 1, and the combination of those two events was .07 inches. This is approximately 1 inch below normal.

The dry, stable air mass that sat over the fire area from August 2-11, caused high temperatures, low relative humidities and strong inversions within the fire area. The inversions would typically break around 1300, resulting in a significant decrease in RHs in a short period of time. For example: a weather observation within the fire area at 1130 on August 9 was 40% RH; at 1230 the inversion had started to break and the RH was 32%. At 1900, weather observations indicated a 12% RH within the fire area. Conditions experienced on August 9 were similar to those after the 9th; until the rain came through the fire area on the afternoon of August 12. The RHs typically bottomed out at 1700 in the low teens to upper single digits and did not recover until approximately 2000.

Temperatures were in the low to mid 90's, tying a 1969 record for continual temperatures above 90 degrees in the month of August. This event was the third longest stretch of continual hot weather since 1897. These temperatures combined with the low humidities, caused the fine fuels to become extremely dry and flammable. During these conditions, fires climb fuel ladders easily, resulting in torching and crowning. Spot fires start more readily with ignition potentials being very high.

There were two Remote Automated Weather Station (RAWS) stations used to provide on-going weather observations for the fire, Nine Mile and Pardee. Nine Mile RAWS was consistent with weather data received from the fire line. Two fire RAWS were placed adjacent to the fire area to provide more weather information and trends. One was placed at approximately 5800' on the south side of the interstate, and the second was placed on an open ridge above the Church Spike Camp at approximately 3800 feet. The two fire RAWS stations were dismantled August 15.

A strong inversion consistently set up over the fire area from August 2-11; recoveries within the valley bottoms were typically in the mid 50's-60's. Areas within the thermal belt received very poor recoveries, often in the mid 30's. Conditions within the thermal belt supported active burning throughout the evening into the early morning.

Once the inversion broke, the winds began to funnel up the northeast to southwest oriented drainages. RAWS sites near the fire area reported sustained winds of 10-20 mph with gusts up to 25 mph out of the southwest. Orientation of many of the drainages within the fire area allowed for a channeling effect to occur with the winds, often causing winds in excess of 30-35 mph. Specific drainages where we observed this type of behavior included South Fork Nemote Creek and West Mountain. On site observations within these specific drainages indicated erratic winds and consistent fire whirls, resulting in spots across fire lines and tight drainages.

On August 12, a front moved into the area, and the winds shifted to the northwest in the early morning and a northeast/easterly component as the front passed through the fire area. The Nine Mile RAWS indicated approximately .2 inches of rain, the two fire RAWS showed .13 and .17 inches of rain. Although this was not a significant amount of moisture, it was enough for crews to get a good foothold on sections of line. As of August 14, the area is heading into another warm and dry air mass with temperatures in the high 80's and low RHs in the mid to upper teens with recoveries in the low to mid 30's midslope and upper 70's within the valley bottoms.

Topography ~

Elevation changes within the fire area were approximately 3500' within the valley bottoms to 6700' on the ridgetops at the north end of the fire. Slope steepness ranged from 15-80% throughout the fire area. The topographical influence had an effect on the wind patterns, especially within the South Fork of Nemote Creek and West Mountain Creek. Locals living within the West Mountain drainage indicated that erratic winds were common throughout the year; during the winter it is common to see whirls of snow instead of fire. It was not uncommon to see large fire whirls at the mouth of the South Fork of Nemote Creek due to wind funneling through this drainage. The drainage is gradual at the mouth, although the sidewalls become steeper as one progresses to the east up drainage.

The southerly aspects are very dry especially at the low-mid elevations; the northerly aspects were also dry and would not retard fire spread where the heavy fuels were present.

The homes affected by the fire are located within the valley bottoms or on more gradual slopes. Road access was developed within these areas allowing crews and engines easy access to protect the homes.

Summary ~

The I-90 complex is a good example of a fire burning under extreme factors that affect fire behavior. There was a variety of fuel beds within the fire area; they were continuous in nature and readily available which, combined with weather and topography, provided extreme burning conditions.

Due to discrepancies about the cause and origin of fires, this portion of the narrative will be general in nature. Fuels along the Frontage Road (accesses West Mountain, Fish and East Alberton) and the west lane of I-90 (access Tarkio) were fine and flashy. Once the fire was initiated it didn't take long for it to become established and influenced by winds. Alberton East and Fish were pretty well contained when the team arrived; West Mountain and Tarkio were the most concerning due to the fuels, prevailing winds, current weather and adjacent homes.

Red flag warnings were issued for extremely warm, dry air combined with winds for the fire area on August 7, 8, 9 and 15th. On August 6, the West Mountain Fire gained approximately 100 acres, running up a south facing slope and across the top portion of the slope to the north. After this initial run, the fire was protected from the strong southwesterly flow and didn't gain significant acreage for the remainder of the fire. Torching and spotting down hill was a concern within this drainage due to the homes in the bottom. One spot of 25 acres materialized below the main fire, but from this point forward the fire held. The Tarkio Fire burned up the south slope on August 5, and slopped over the ridge into the industrial timber ground. This area had been recently harvested leaving behind a continual fuel bed of red logging slash. Crews made progress within this area although, due to the continuous fuel loads, fuel moistures and erratic winds, their efforts had little effect on slowing fire spread going up the drainage. Winds within this drainage were unpredictable as they funneled up the South Fork of Nemote Creek; it was not uncommon to see large fire whirls as a result of the topography and winds. On August 9, a spot fire occurred across the South Fork of Nemote Creek. The spot was within fine fuels, probability of ignition was 90% on the southerly slopes.

On August 10, there was no red flag warning issued although conditions were expected to remain the same in regards to RH recoveries, temperatures and expected winds. Despite efforts with retardant and water drops, the spot fire became well established on the southerly slope. The alignment of fuels, weather and topography provided conditions for the fire behavior to become very active in the early afternoon and persisted until approximately 2200-2300. The fire burned up the South Fork spotting up to 1 mile ahead of the fire front: fire growth was approximately 4500 acres. The fire slopped over the ridge into the Sheridan Creek drainage on the north aspect. The northerly aspect consisted of several treated (prescribe burned and planted) cutting units, the fuels were discontinuous and predominantly 1000 hour. These fuels were receptive to ignition but fire behavior was minimal on this aspect. The fire spread at slow rates of spread from log to log, this modification in the fuel bed allowed an opportunity for crews to implement direct attack suppression activities.

Areas that experienced a high intensity fire included the private industrial ground with residual activity slash, upper ends of South Fork Nemote Creek and upper south facing slopes above the Clark Fork River. Areas within the Moose Creek drainage burned with low -moderate intensities, depending on location on slope and aspect. This area was burned out through hand ignition to keep fire from backing towards homes in the valley bottom, and to prevent fire from becoming initiated in the bottom of Moose Creek and taking a run to the ridgeline potentially throwing spots into the upper end of West Mountain Creek. There will be some tree mortality within the Moose Creek drainage; the ponderosa pine component should pull through fairly well.

A good portion of the area was accessible by roads which aided crews in suppression efforts. Division C was probably the toughest due to the steep, rocky terrain and limited road access along the bottom.

Fire has been a regular visitor to many of these sites; more specifics can be found from the local unit within their fire history files. Fire history also shows that fires within this area typically are most active in drainages that are oriented to the wind (southwest to northeast) which is indicative of what we saw within the I-90 complex.

Tami Parkinson
Fire Behavior Analyst
Northern Rockies Incident Management Team

APPENDIX - C

Personal Protective Equipment Report – I-90 Complex Shelter Deployment

This equipment report is based on both inspection of equipment and interviews of the three firefighters who deployed shelters on August 10, 2005 at the I-90 Fire Complex. Equipment inspection, firefighter interviews and follow-up interviews occurred between August 12 and August 17, 2005.

Personal Protective Equipment – All three firefighters were appropriately equipped with personal protective equipment that included flame-resistant clothing, 8-inch high leather boots, leather gloves, a hard hat and eye protection. Two firefighters also used face/neck shrouds.

Clothing –The clothing showed no signs of heat damage and performed as designed.

Training – According to the firefighters' red cards and interviews, all firefighters had fire shelter training with the New Generation Fire Shelter earlier in 2005. Each had watched the training video and practiced a shelter deployment.

Fire Shelters and Fire Shelter Bags: Fire shelters were inspected on site on August 12 and at MTDC on August 15. They were examined for heat damage and other structural damage.

- None of the shelters showed any heat damage indicating that the combination of radiant and convective heat was not sufficient to raise the temperature of the material above 500 degrees F.

- DOZB-A shelter – New Generation Fire Shelter, Retrofit, Anchor Industries. Manufactured June 2003.
    - Numerous small cracks (less than 1/8-inch long) in aluminum foil along top shell folded edge of shelter. The cloth remains intact.
    - Two small cracks (less than 2-inches long) in aluminum foil along stitch line between main panel and end panel of shell. Stitching and cloth remain intact.
    - One tear (2 ½-inches) in stitched seam of inside corner of floor opening.

- DOZB-B shelter – New Generation Fire Shelter, Revision C, Weckworth Manufacturing. Manufactured November 2004.
    - One tear (1-inch long) in stitched seam of inside corner of floor opening.

- Dozer Operator shelter – New Generation Fire Shelter, Revision C, Anchor Industries. Manufactured September 2004.
    - No structural damage.

The fire shelter bags were also inspected:

- All bags were found in the deployment site.
- All bags opened along the tear strips.
- One bag showed a melt mark ½-inch in diameter indicating that hot embers blew into the deployment area.

Discussion: The fire shelters and bags performed as designed. The amount of wear seen in the three shelters is as would be expected under the conditions of this deployment and should not have increased exposure of the occupants.

Shelter Experience – The following information was gathered through personal interviews:

- At 1830, the firefighters removed personal gear bags and a case of bottled water from the back of the truck and piled them on the edge of the safety zone. The firefighters stashed a second case of bottled water and their line gear packs with fire shelters next to the blade of the dozer. Fusees were thrown clear of the deployment site.
- At 1850, while observing the oncoming fire, all three firefighters were positioned in front of the dozer blade using the dozer as a barrier between themselves and the fire.
- At 1900 all three firefighters deployed fire shelters.
- During the deployment winds were estimated at 40 miles per hour in the deployment site. On the slope above the site the winds were estimated at 50 to 80 miles per hour. After exiting the shelter the winds diminished to an estimated 15 miles per hour.
- DOZB-B and Dozer operator deployed directly next to the dozer's 10-foot blade while DOZB-A deployed his shelter next to DOZB-B and Dozer operator. (See Diagram 1.)
- All three firefighters were able to communicate with each other during the deployment by yelling. They were joking some to lighten the mood. Water bottles were passed among the firefighters.
- All three firefighters reported that they did not feel the situation was life threatening.
- Personal reports:
    - Dozer Boss-A: (6 feet, 260 pounds) acts as the fire shelter trainer at his home unit. He pulled his chin strap on after winds lifted his hard hat. He reported that when the flames extended from below the road to 30 feet over their heads and the heat was uncomfortable, he went to his knees and made the call to shelter. He said, "its time – deploy." After pulling the red tear strip of the shelter bag, he started the deployment sequence, as he would have with the old-style shelter, by looking for the shelter's side seam. He soon grabbed the appropriate shake handles, shook out the shelter and was able to be fully deployed inside the shelter very quickly while lying on the ground. He reported the floor worked well and made it easy to hold the shelter down. Hot embers blew under the shelter. High winds that buffeted the deployment site pushed the shelter shell down onto the firefighter. He was able to push the shelter shell up with his gloved hand and elbow. He estimated that temperatures inside the shelter rose to 90-100 degrees F. After the initial blast of radiant heat lasting 1 to 2 minutes, the firefighter was able to lift the shelter floor slightly to view the area which allowed cooler air to enter the shelter. He also moved around inside the shelter to view other areas of the deployment site. While under the shelter DOZB-A attempted to call DIVS M, but was unsuccessful. When he felt it was safe to do so, he sat up to transmit and called IHC-A Sup to inform them of the shelter deployment and that they were fine with no injuries. (IHC-A Sup also heard the earlier calls to DIVS M.) He then redeployed his shelter. DOZB-A exited the shelter fully after an estimated 10 minutes. With the shelter draped over his shoulders he inspected the deployment site and nearby fire activity. DOZB-A commented that while at the deployment site all safety measures were used, that the shelter is the last tool for safety and the last tool was used. He reported that the fire shelter worked well. He also felt that the large size shelter would be more appropriate for him.
    - Dozer Boss-B: (5 feet 11 inches, 205 pounds) reported that he decided to use the shelter after feeling the ember wash and radiant heat and upon hearing DOZB-A's

call for shelters. He felt concern about the possibility of an investigation when he pulled the red tear strip, but once the decision was made he did not hesitate to deploy. He reported an easy deployment. In order to stay behind the dozer blade for its added protection, he did not lay fully prone, but lay in a semi-fetal position. Inside the shelter he felt claustrophobic. There were lots of ¾ to 1-inch embers, small rocks, and dust being blown by the wind, but there was not much smoke in the deployment site. After 2 minutes he was able to lift the shelter edge and view the fire burning through the small timber above the site. He noticed the gear bags behind the truck were on fire. He estimated the total time in the shelter was 5 minutes.

- Dozer Operator: (6 feet 3 inches, 190 pounds) reported that he noticed ember fallout and within 15 seconds it got very hot from radiant heat. DOZB-A made the call to open shelters. The dozer operator reported that it was too hot to stand to deploy, so he deployed while on his knees, shielded by the dozer blade. The foot end of shelter was blown around until he was able to get his feet in the shelter to hold it down. He did not fully deploy in a flat prone position, but curled into a semi-fetal position in order to use the dozer blade for protection and to remain on top of the line gear belonging to the other two firefighters. Since the dozer blade was resting on the ground and not dug in, embers were able to blow under the blade and into the deployment area. He could see the orange glow of fire and smoke through the seams of the shelter. After a few minutes, he lifted the edge of the shelter to view the surroundings which allowed cooler air to enter the shelter. He was able to grab a couple of water bottles from the case of water previously placed by the dozer blade to share with the others. Dozer operator reported that if they had not had shelters and had not used the blade of the dozer, they would have had burns due to embers and intense heat. He also reported the dozer blade and grappling hook were hot to the touch after the deployment. The dozer operator felt that the large size shelter would be more appropriate for him.

Additional information about the deployment:

- The firefighters used the dozer to remove fuel inside the road switch-back.
- The case of bottled water that was in the deployment site, near the dozer showed no signs of heat damage while the case of bottled water on the east edge of the safety zone did show signs of heat damage. Polyvinyl Chloride (PVC), the substance from which the bottles are made melts at 285 degrees F. This indicates that the radiant and convective heat at the deployment site was not enough to raise the temperature of the PVC bottles past the melting point, but was great enough at the edge of the safety zone.
- The pile of personal gear bags on the east edge of the safety zone burned.
- Small patches of grass on the road cut bank did not burn.
- No heat damage was found on the dozer or the pickup truck.
- Most areas outside the safety zone were black and appear to have burned in a crown fire.

Discussion: Areas on both sides of the safety zone all burned as a crown fire. The deployment area appears to have provided considerable protection from the intense fire behavior. The combination of the protection offered by the deployment site, the dozer and the fire shelters allowed the firefighters to remain unharmed (See Diagram 2 and 3).

The firefighters made many good decisions during this deployment:

- The site chosen was the best available to them after their initial escape route was reported to be compromised. The site had a wide bench/road, a steep cut bank above the site, and road fill below the site, all of which were mostly void of fuel. Flat areas on slopes, such

as benches or road cuts such as this, offer some protection from radiant and convective heat.
- The firefighters used their time wisely to improve the site by removing fuel inside the road switchback.
- The firefighters used the dozer as an added barrier against radiant and convective heat.
- The firefighters removed fusees from their packs and threw them clear of the site.
- The firefighters pre-positioned water at the deployment site. These firefighters had time to do so. Firefighters should take time to retrieve water only if time permits.
- The firefighters removed personal gear bags from the pickup truck to lessen the chances that the truck, which was close to the deployment site, would burn.

While the decisions the firefighters made clearly led to the positive outcome of this incident, the following are reminders to all firefighters:

- Firefighters should deploy their shelters before the flame front arrives if time permits.
- Firefighters should not hesitate to deploy a shelter if it is needed for protection. While the shelter is considered a last resort, it is prudent to use the shelter even for protection against smoke and embers. Firefighters should not worry about the cost of the fire shelter or a possible investigation. Their safety is always the highest priority.
- Firefighters may need to do extra practice deployments in order to become proficient with the New Generation Fire Shelter.

The New Generation Fire Shelter:
- This is the first known deployment of the New Generation Fire Shelter.
- The firefighters commented that the shelter worked well in this deployment.
- Information learned from this deployment will be used to continue development work on the New Generation Fire Shelter.

/s/ Tony Petrilli *August 19, 2005*

Tony Petrilli — Date
Equipment Specialist
Missoula Technology and Development Center

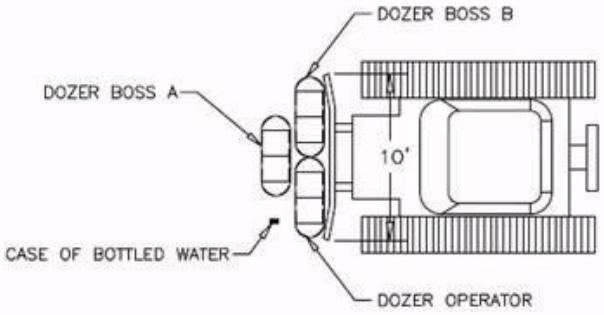


Diagram 1

Diagram 1

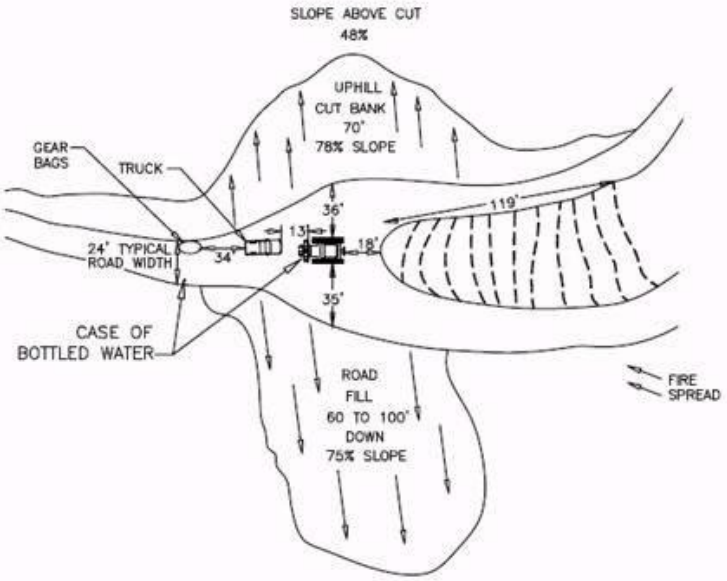


Diagram 2

Diagram 2

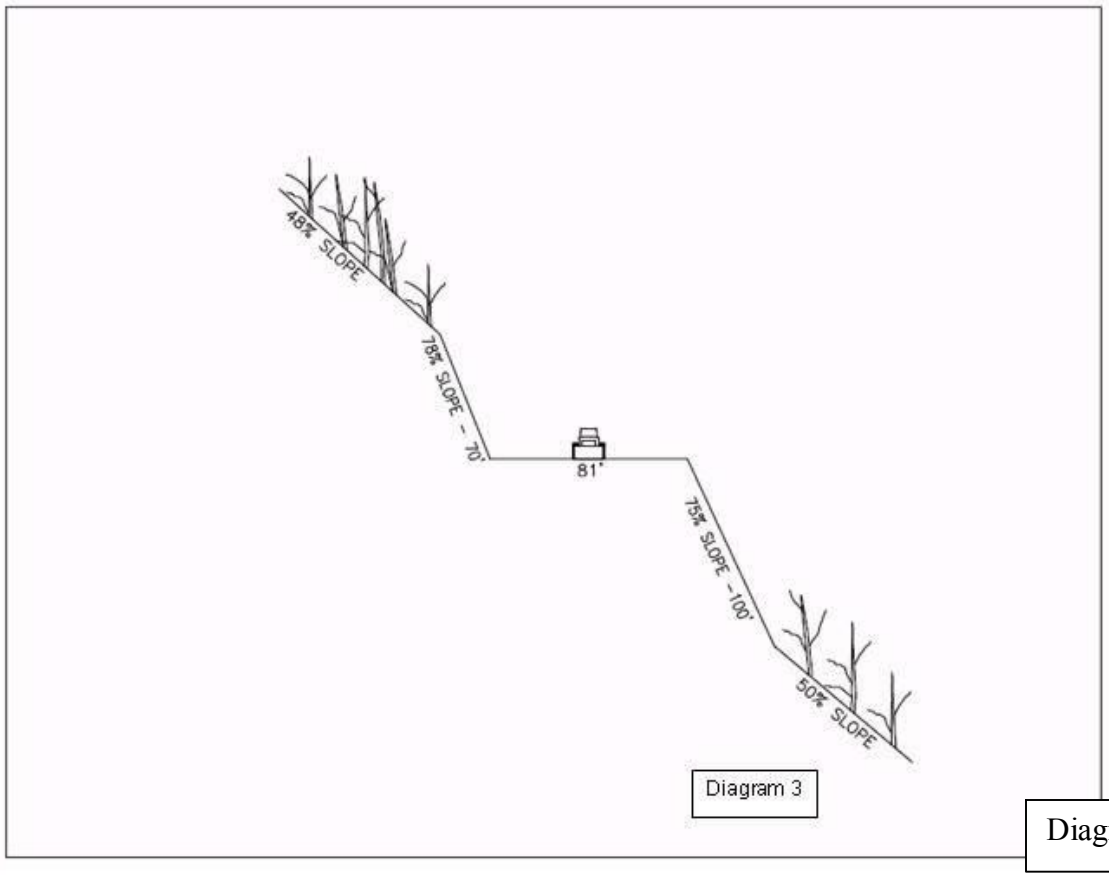


Diagram 3

Lessons Learned Analysis

FIRE SHELTER DEPLOYMENT
I-90 COMPLEX, LOLO NATIONAL FOREST
NORTHERN ROCKIES
MISSOULA, MONTANA

August 10, 2005

Prologue

As fire brands pelted three firefighters, and even the blade of a caterpillar dozer could not fend off radiant heat, the leader uttered the words "Oh Shit!", and directed his comrades to deploy their fire shelters. The "Oh Shit!" was not in reference to the rapidly escalating conflagration approaching them, for they knew they were in a good place, and the thin laminated reflective fire shelter would offer more than adequate protection. "Oh Shit!" expressed the ominous realization that their simple act of self protection would initiate an agency and news media chain reaction that might follow for years to come.

Introduction

"Shelter deployment,"--two words that can and should, strike fear in any firefighter. Certainly, the potential ramifications of injury, and possibly even death, associated with those two words are responsible for a good share of that fear. But how much of that apprehension is associated with the simple act of using "the tool" itself, and the resulting actions that follow to critique their decision?

We, the investigation team, believe that we could qualitatively describe a reasonable trigger point for appropriate use of a fire shelter that most could agree with. Potential for serious injury or potential fatality situations are obvious. Situations involving avoidance of significant discomfort due to fire embers or smoke may not be as obvious. But it is the individual's interpretation of when that "correct time" is, that is of concern. In a deployment situation, some individuals might choose to deploy earlier, which is certainly the lesser concern. But some individuals, due to the stigma and resulting reactions to follow, might choose to wait beyond that reasonable point, and risk injury or even death. The fact that when, at that critical decision point, a firefighter may be thinking more about the bureaucratic consequences of shelter deployment, rather than the fire itself and their own personal safety, begs the question as to whether a cultural course correction is warranted.

It is our hope that this report will accurately tell the story. Loaded words with complicated overtones have been avoided. The only suggestion for alternative actions comes from the individuals involved in their own words. It is their hope, and the objective of this investigation team, that the telling of this experience will lead to a culture where firefighters will execute critical maneuvers in a timely manner, confident their firefighting community and host agency will support them in their decisions.

Investigation Process

An investigation team was assembled to review the shelter deployment incident, which occurred on August 10, 2005. The Regional Forester, Northern Region, initiated the review. The Regional Forester issued a delegation of authority, to the Investigation Team Leader on August 11, 2005. The investigation team assembled in Missoula, Montana on August 11, 2005, and received an in-briefing at the Regional Office. The investigation team traveled that same day to the Ninemile Incident Command Post (ICP) and received a briefing from the Incident Management Team (IMT) and was provided preliminary documentation.

The investigation team members were:

- Bruce Fox, Team Leader (Director of Forest and Rangeland Management, R1)
- Peter Tolosano, Chief Investigator (Fire Operations Safety Manager, Pacific Southwest Region)

- Paul Chamberlin, Safety Manager/Fire Operations (Northern Rockies Fire Operations Safety Manager)
- Anthony "Tony" Petrilli, Equipment Specialist (Equipment Specialist, Missoula Technology and Development Center)
- Mike Waldron, NFFE representative (Smoke jumper, Missoula)
- Janet Oestreich, Primary Documentation Specialist (Supervisory Program Assistant, R1 Regional Office)
- Jennifer Durilla, Secondary Documentation Specialist (Office automation assistant, R1 Regional Office)

On August 12, the team provided a 24-hour briefing memo to the Regional Forester and began interviewing involved personnel at the ICP, including a visit to the deployment site with the principle individuals involved. The investigation team interviewed or reviewed statements from individuals or crews that were directly or indirectly involved with the shelter deployments. During this time, the team also completed a 72 hour report to the Regional Forester. The team utilized an after action review process approach during interviews that asked the basic questions:

- What was planned?
- What actually happened?
- Why did it happen?
- What would you do differently in the future?

The team then completed the process of compiling a chronology through established facts from witnesses, developed a list of findings and causal and contributing factors, and developed recommendations to be transmitted with this report.

As an interesting side note to this investigation, the investigation team was given an additional charge. Within the boundaries defined by policy and pursuant to the appropriate guidelines, the investigation team was encouraged to take a different approach in the investigation, towards a principles/doctrinal-driven review rather than a rules-driven review. A rules driven approach simply identifies which rules may have been violated at the time the incident occurred, and does not provide a meaningful measure of performance. A principle/doctrinal driven review focus on those things that drove the decision-making and the behaviors of those involved. These values are consistent with Managing the Unexpected, High Reliable Organizations (Appendix B) and the Lessons Learned Center. The investigation team accepted this charge and made their best effort to reflect that thinking throughout this report.

NARRATIVE

Introduction

The I-90 Fire Shelter Deployment on August 10 was determined to be a close call. Three firefighters found themselves in a position where deploying their shelters was essential. Their training in the use of this tool and the tool itself proved effective. This report will describe the salient points of the incident and tell a story

All recommendations come from the people involved, in their sincere hope for all of us to learn.

(Photo 1)
The I-90 Fire is a complex fire, with complex terrain, complex weather, complex fire behavior, and a complex firefighting organization. Some of our best people were involved. The investigation team has been tasked to avoid a 'checklist compliance' type of investigation and instead, look at the whole picture, considering the commanders intent, individual's understanding of that intent, their understanding of firefighting fundamentals, how they applied what they understood, and the decision making and risk management process used by firefighters in this situation. We have every reason to believe these firefighters are dedicated public servants committed to do the best thing for the land and the taxpayer. In a doctrine based investigation, individuals will be held accountable for their decisions. Those decisions should be evaluated as to whether they are reasonable and prudent based on doctrine, training, and experience given the context of the situation.

We recognize and accept the risks associated with fire suppression. We depend on our doctrine, training, skilled experience, and leadership to mitigate those risks. Disregard for these recognized risks and failure to practice risk management is unacceptable, regardless of whether or not it results in injury or death. These values reflect the principle of 'Doctrine' currently finding voice after the Pulaski Conference. This report may emerge as a transitional document helping define what a doctrine based investigation looks like.

With doctrine in mind, Lookouts, Communications, Escape Routes, and Safety Zones (LCES) were the mitigations practiced by firefighters and supervisors on the I-90 Complex. LCES emerges as an example of an 'Operational Principle' embraced by the workforce.

Another value traditionally core to wildland firefighters is learning from our mistakes. *(Reference Appendix A – In Light of a High Reliability Organization)* This report represents an effort to learn from a close call, and not wait for a tragedy. This investigation was triggered by the deployment of shelters. However, a more dangerous condition could have developed, and without the deployment, we would not have pursued the well-documented learning experience. It must be assumed that practices on the I-90 Fire are representative of practices by good people on many other incidents.

The Plan

The Incident Action Plan (IAP) discussed weather and fire behavior for each portion of the fire. A fire behavior prediction did not exist for Division M but it was understood by all that the prediction for Division L, South Fork of Nemote Creek included Division M. Fire Weather predictions were similar to what actually occurred. Safety was addressed on the first page of the IAP with 6-Minutes for Safety, and was the obligatory first objective on the second page, with reference to 10 and 18, and direction to implement the specialized instructions on each division assignment sheet. Each division assignment sheet was composed for the situation on that division, versus a generic repeat from page to page. The safety message focused on driving issues, reviewed the basics, provided kudos for examples of positive behaviors the previous day, and a reminder to keep safety before mission, including the power line. Anticipating change and updating and communicating LCES elements was articulated. A heads up regarding spot fires altering routes for Division L speaks to what was eventually experienced and accomplished in Division M.

The Situation

This report will focus on the events germane to the shelter deployment, including the August 10 fire spread in the South Nemote Creek canyon, and suppression activities on the north facing slopes in Division M. To make an effective report, many peripheral details are not mentioned.

Red Flag warnings for extreme fire weather were issued for August 8 and 9 however, there was no Red Flag Warning issued for the 10th. The number of sequential days of hot dry weather was at record levels. The steep terrain included old fire scars, logging slash, continuous timber, clearcuts, brush and grass and many logging roads. The firefighting forces in the South Fork of Nemote Creek drainage included interregional hotshot crews, engines, and dozers. Supervisory overhead included Operations Section Chief, Safety Officers, Dozer Bosses, Division Supervisor, Branch Director, Lookouts, and a Fire Behavior Analyst (FBA). Previous efforts to cut off the fire proved ineffective, and there was strong direction to prevent the fire from burning under a major power line.

Lessons Learned

Knowing the outcome, it would be easy to criticize individuals and the IMT regarding elements of this story. We ask the reader to avoid that and instead, use this experience to improve your own 'recognition primed decision making', and be grateful for the openness of the participants in sharing what they would do different next time.

Some organizations, worried about reputation and prestige, might look at this incident and say "Well! We are good! Everything worked! We only had a close call 'precautionary' deployment." On the other hand, a Learning Organization, a "High Reliability Organization", will say "Wow! We dodged the bullet on this one. This is an indicator of how close to the edge we actually are. This is an inexpensive lesson that we must learn all we can from. We know these are good people, and any one of us could have been in that position".

Most of us start thinking about the Dozer Bosses, and when they got the dozer moving. An outside observer (knowing the outcome) would say "Obviously they should have abandoned the dozer and put the operator in the pickup and got out of there." And Dozer Bosses agree. But that is only a portion of the lessons here. Dozer Boss-A speaks of staying with the operation / mission and the fire behavior experienced the previous days, and that morning. He thinks of the indicators of bigger things to come when the wind increases and aligns with the canyon, when the slopover across the canyon becomes active, and the discussion the day before with an Asst. Hot Shot Sup, regarding wind alignment. In his words, "I was thinking one ridge ahead, and I need to be thinking at least two ridges ahead."

The Lookout, from IHC-A watches the scenario unfold, and dutifully makes observations back to the crew. With 20/20 hindsight, he knew in his 'gut' (his word) this was a lost cause, but did not speak his mind. As this young man will someday be leading crews, this lesson will not be lost.

The trainee ATGS has a strong 'gut' (also her word) feeling that she needs to voice her concerns with the ground forces, and help them identify triggers for when it becomes a lost cause.

A weather update for 1500 was never delivered to Communications. While the update suggested only an incremental increase in wind, we have to wonder if that would have gotten people's attention. That IMET has already alerted his community, and shared his perception that the update fell through the cracks with the arrival of a new trainee.

In light of a High Reliability Organization, or better yet, *Organizing*.

Dr. Karl Weick was an important contributor to the original Wildland Firefighters Human Factors Workshop. Along with Dr. Kathleen Sutcliffe he has published Managing The Unexpected, Assuring High Performance in an Age of Complexity. Sutcliffe and Weick have assisted the wildland fire community present Managing the Unexpected conferences in Santa Fe, NM and Jacksonville, Fl. and we have visions of bringing one to Missoula in 2006.

The following is a very brief introduction to Managing the Unexpected, and an informal integration of events on the I-90 fire. The quotations are from Weick and Sutcliffe's book.

Hallmarks of High Reliability

- Preoccupation with Failure
- Reluctance to Simplify
- Sensitivity to Operations
- Commitment to Resilience
- Deference to Experience

- Preoccupation with Failure

  "Even though High Reliability Organizations are noteworthy because they avoid disasters, they do not gloat over this fact. Just the opposite. *They are preoccupied with their failures*, large and small. They treat any lapse as a symptom that something is wrong with the system, something that could have severe consequences if separate small errors happen to coincide at one awful moment. High Reliability Organizations encourage reporting of errors, they elaborate experiences of near miss for what can be learned, and they are wary of the potential liabilities of success, including complacency, the temptation to reduce margins of safety, and the drift into automatic processing."

  In this I-90 Shelter Deployment, the firefighters on site conducted an After Action Review, the Incident Management Team recruited the assistance of the Regional Fire Safety Specialist, and the Regional Office initiated this investigation.

  On the other hand, at the agency level, there were loaded words (such as precautionary) shaping peoples thinking, hoping for a non-event instead of focusing to maximize learning.

- Reluctance to Simplify

  "Success in any coordinated activity requires that people simplify in order to stay focused on a handful of key issues and key indicators. High Reliability Organizations take deliberate steps to create more complete and nuanced pictures. They simplify less and see more. Knowing that the world they face is complex, unstable, unknowable, and unpredictable, they position themselves to see as much as possible. They encourage boundary spanners who have diverse experience, skepticism toward received wisdom,

and negotiation tactics that reconcile differences of opinion without destroying the nuances that diverse people detect."

So, nice going- we reduce the 28 elements 10 & 18 to Lookouts, Communications, Escape Routes and Safety Zones (LCES), which on the surface looks like a simplification contrary to this Hallmark. However, study reveals LCES is a deep well, offering many opportunities for deeper insight. On I-90, it is the devil in the details related to a dozer's travel time, and the distance / time to a safety zone. As the dozer leaves the bottom of the Division M Dozer line, it is leaving close proximity to the blackened safety zone used by Interagency Hotshot Crew-A. The Dozer bosses are not thinking at this point that this situation is any different than the previous day, and there is no rush to get the dozer up the hill. With a commitment to less simplification, the escape route relationships to safety zones are being constantly calculated, as constant as heartbeats.

Look at the complex network of cooperation between the resources on this section of Division M. Dozer boss-B is watching out for Interagency Hotshot Crew-A, and a little later, Interagency Hotshot Crew-A Supervisor is watching out for the dozer. All of these people are informed and engaged in the safe execution of the plan, and then the egress.

- Sensitivity to Operations

"Sensitivity to operations points to an ongoing concern with the unexpected. Unexpected events usually originate in 'latent failures' which are loopholes in the system's defenses, barriers and safeguards who's potential existed for some time prior to the onset of the accident sequence, though usually without any obvious bad effect." Normal operations may reveal deficiencies that are "free lessons" that signal the development of unexpected events." And "People in High Reliability Organizations know that you can't develop a big picture of operations if the symptoms of those operations are withheld, …whether they are withheld out of fear, ignorance, or indifference."

The presence of an Operations Section Chief and Safety Officer working side by side with the Division-M in Division M, and the presence of another Operations Section Chief just over the hill in Division-H where another critical event was unfolding shows a commitment by the Operations section to be engaged, on site, and feeling the pulse.

A reluctance to speak up emerges in at least two places, with mid career individuals at the Lookout, and as the trainee in the Air Attack ship.

- Commitment to Resilience and Deference to Experience

"High Reliability Organizations develop capabilities to detect, contain, and bounce back from those inevitable errors that are a part of an indeterminate world. The signature of a High Reliability Organization is not that it is error-free, but that errors don't disable it." "Resilience is a combination of keeping errors small and of improvising workarounds that keep the system functioning. These avenues of resilience demand deep knowledge of the technology the system, one's coworkers, and one's self, and the raw materials. High Reliability Organizations put a premium on experts; personnel with deep experience, skills of recombination, and training. They mentally simulate worst case conditions and practice their own equivalent of fire drills."

And as to Deference, "High Reliability Organizations cultivate diversity, not just because it helps them *notice* more in complex environments, but also because it helps them do

more with the complexities they spot. Rigid hierarchies have their own special vulnerability to error. Errors at higher levels tend to pick up and combine with errors at lower levels, thereby more prone to escalation… High Reliability Organizations push decision making down—and around. Decisions are made on the front line, and authority migrates to the people with the most expertise, regardless of rank"

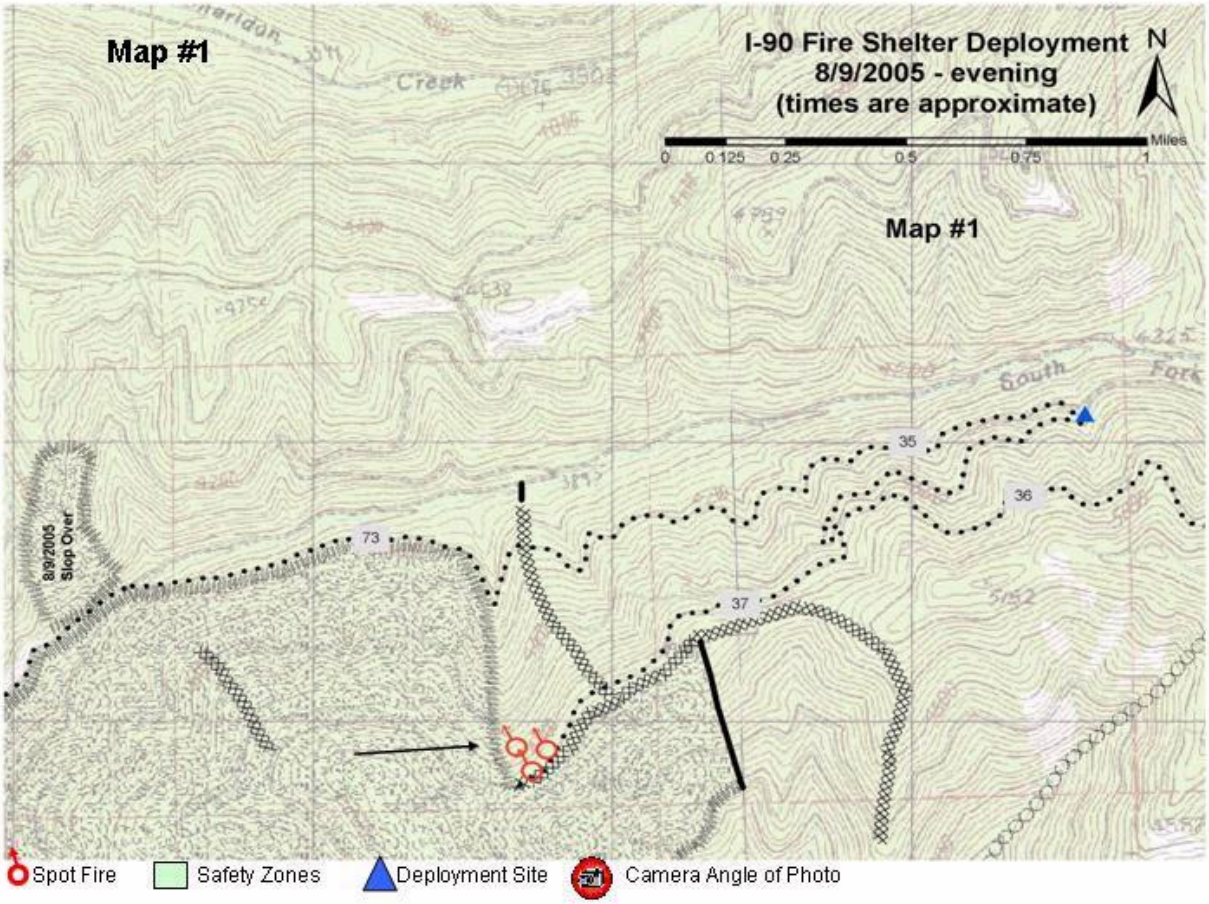
As the situation escalated, most supervisors were thinking they had covered all the bases that the fire blow-up was well prepared for, and all firefighters were safely in safety zones, or out of the area. They had run 'fire drills' as escape routes and safety zones were being confirmed; however, the actual travel pace of the dozer for an actual 'worst case scenario' was missed.

When the Dozer bosses recognized the grind to the upper safety zone was not going to happen, and now the alternate escape route was in question. Taking charge in the moment, they chose a sure thing at the switchback. This site was not woven into a plan or mentioned in briefings. But both Dozer bosses are also Division Supervisors, and with many years experience ***noticed*** the relatively wide switchback area. Both Resilience and Deference to Experience are exemplified.

Photo #1

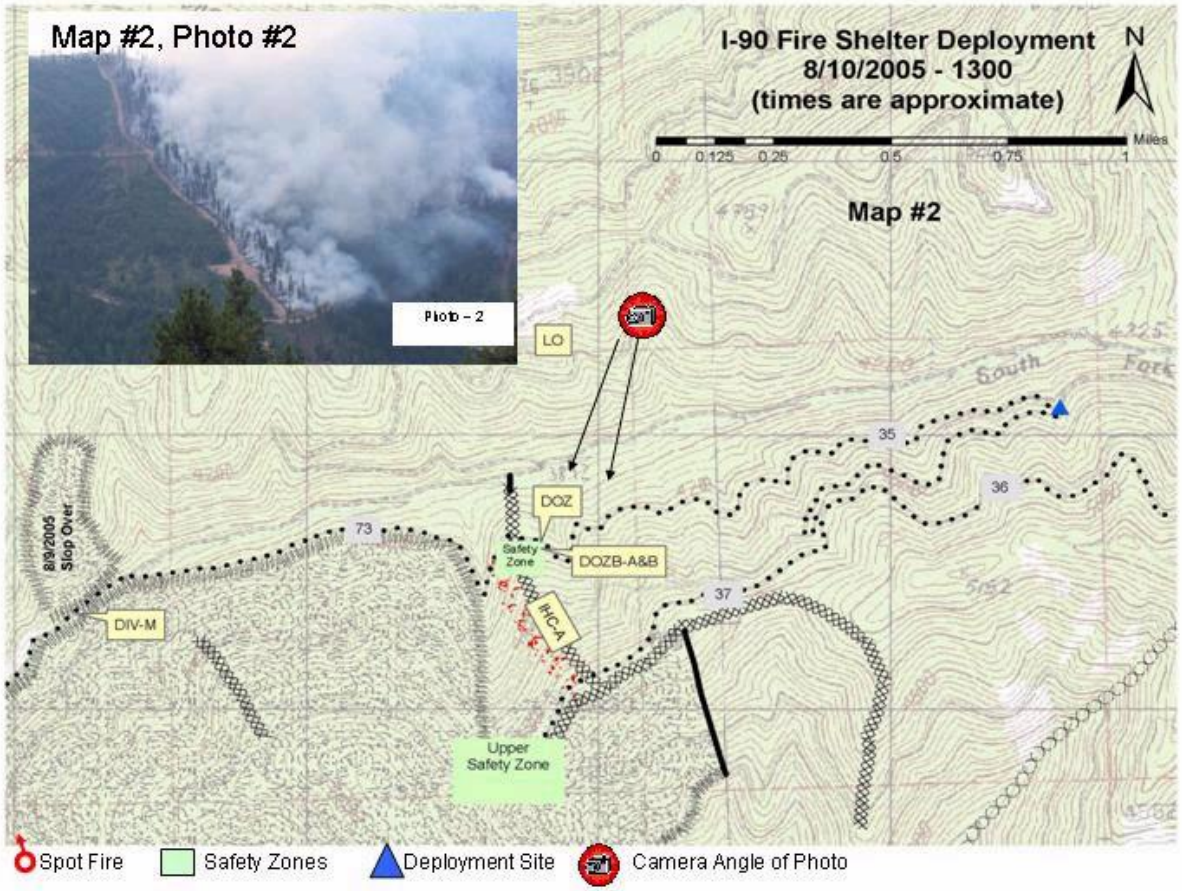
(Photo 1)

The I-90 Fire is a complex fire, with complex terrain, complex weather, complex fire behavior, and a complex firefighting organization. Some of our best people were involved. The investigation team has been tasked to avoid a 'checklist compliance' type of investigation and instead, look at the whole picture, considering the 'commanders intent', individual's understanding of that intent, their understanding of firefighting fundamentals, how they applied what they understood, and the decision making and risk management process used by firefighters in this situation. We have every reason to believe these firefighters are dedicated public servants committed to do the best thing for the land and the taxpayer. In a doctrine based investigation, individuals will be held accountable for their decisions. Those decisions should be evaluated as to whether they are reasonable and prudent based on doctrine, training, and experience given the context of the situation.



(Map 1)

This map shows the location of the fire and dozer fireline from the night before. Notice that the burnout from the adjacent division spotted over the ridge, and through the night blackened the south side of the saddle. This worked well for Interagency Hotshot Crew-A, who began the day with a meaningful safety zone (Upper Safety Zone) with black on both sides of the ridge.

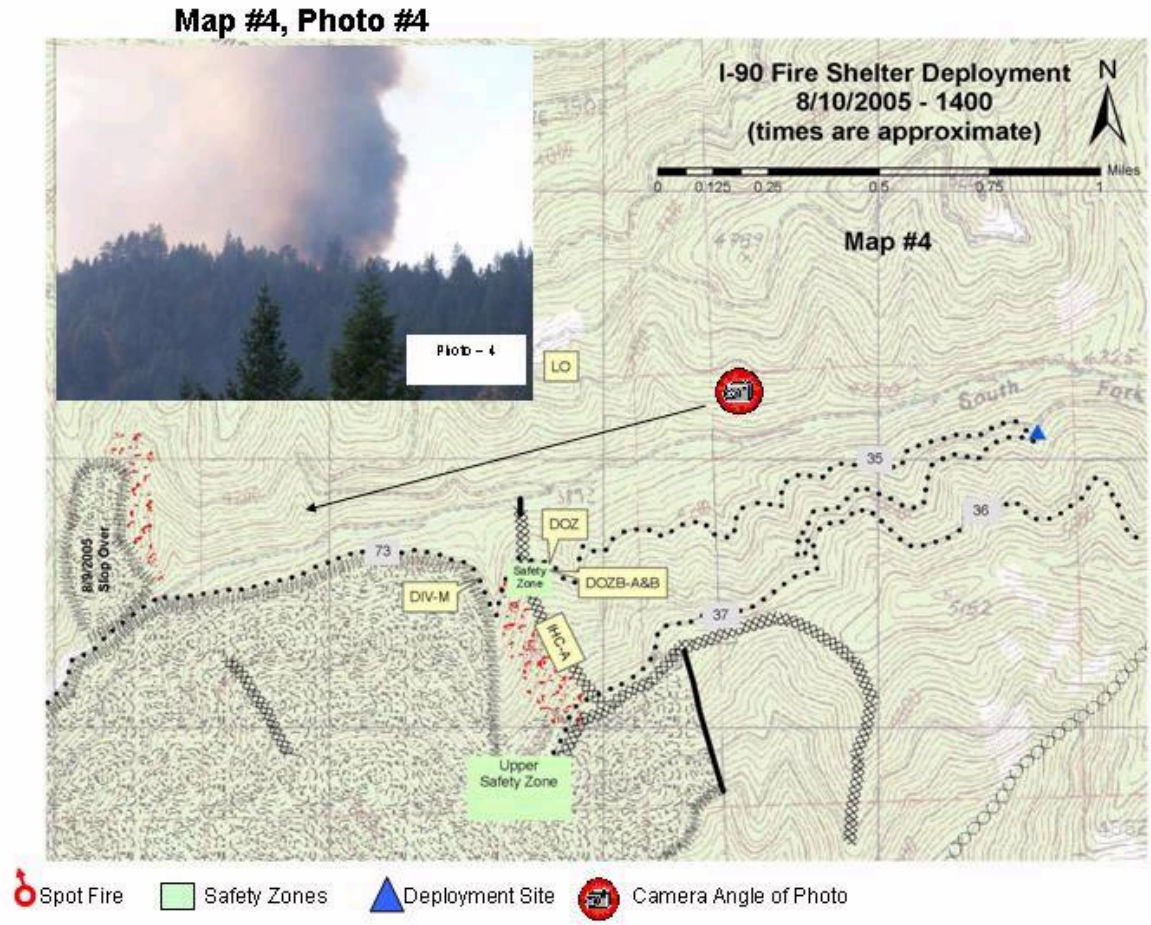


(Map 2 – Photo 2)

Interagency Hotshot Crew-A also posted a lookout directly across the canyon. With this anchor and lookout, Interagency Hotshot Crew-A burned out from the top down. The Dozer widened this line, heading south, towards South Fork of Nemote Creek, creating a safety zone just above the 35/73 Road. A handline completes the line into the riparian area. Everything below the 35 / 73 Road is considered a contingency line, as they intended to hold the fire above the road, and west of the dozer line. Map 2 also shows the dozer line at 1300 as the Interagency Hotshot Crew-A completes burnout operations.

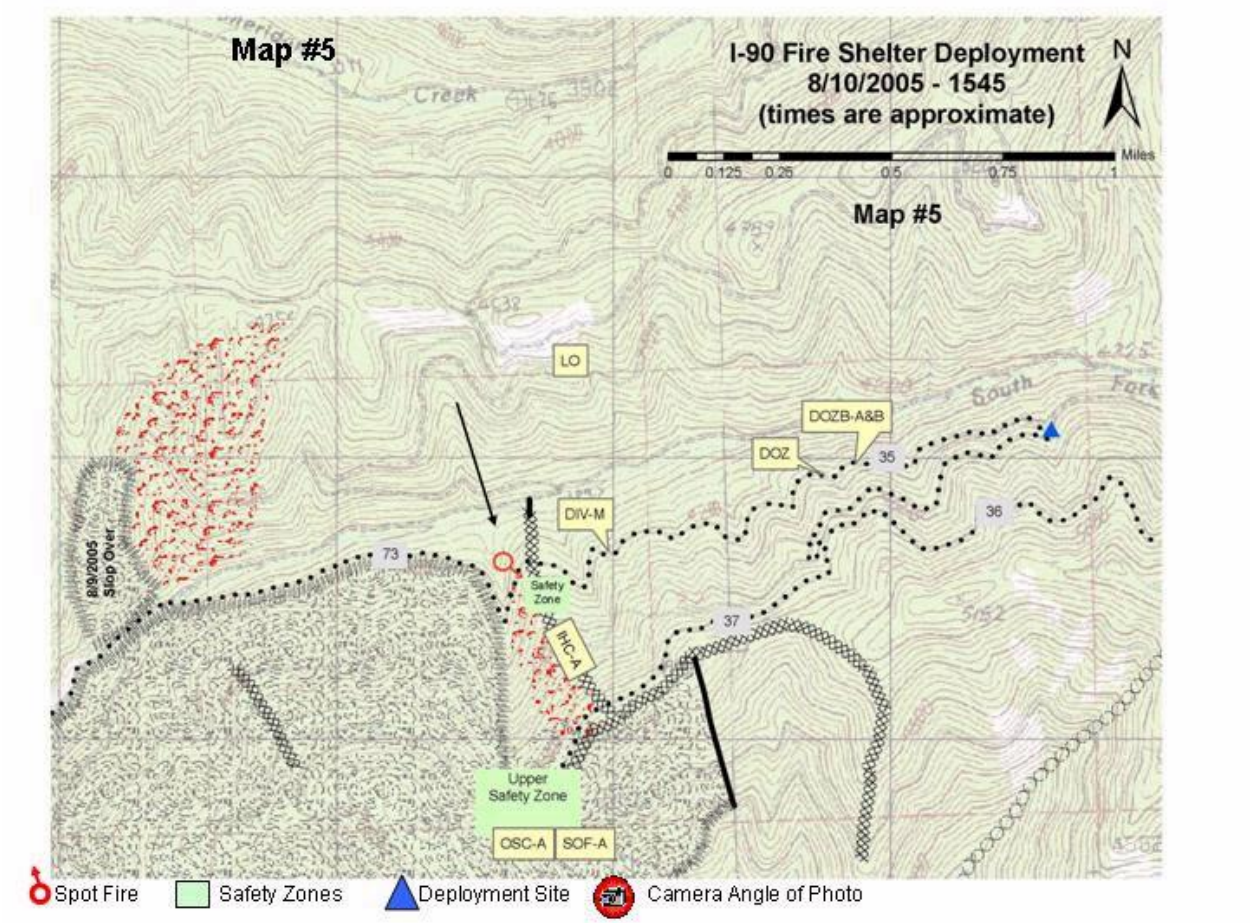
(Map 3 – Photo 3)

The magnified photo inset shows the dozer at the bottom of this line on the 35 / 73 Road. At this time the Dozer Bosses are nearby eating lunch, and looking out for spots, rollouts, and watching the slopover downstream on the opposite side of the canyon.



(Map 4 - Photo 4)

First reports of the inversion lifting are at 1200, and fire behavior incrementally increases for the rest of the afternoon, just as it had on previous days. At 1400, they notice the slopover across the canyon becoming more active.

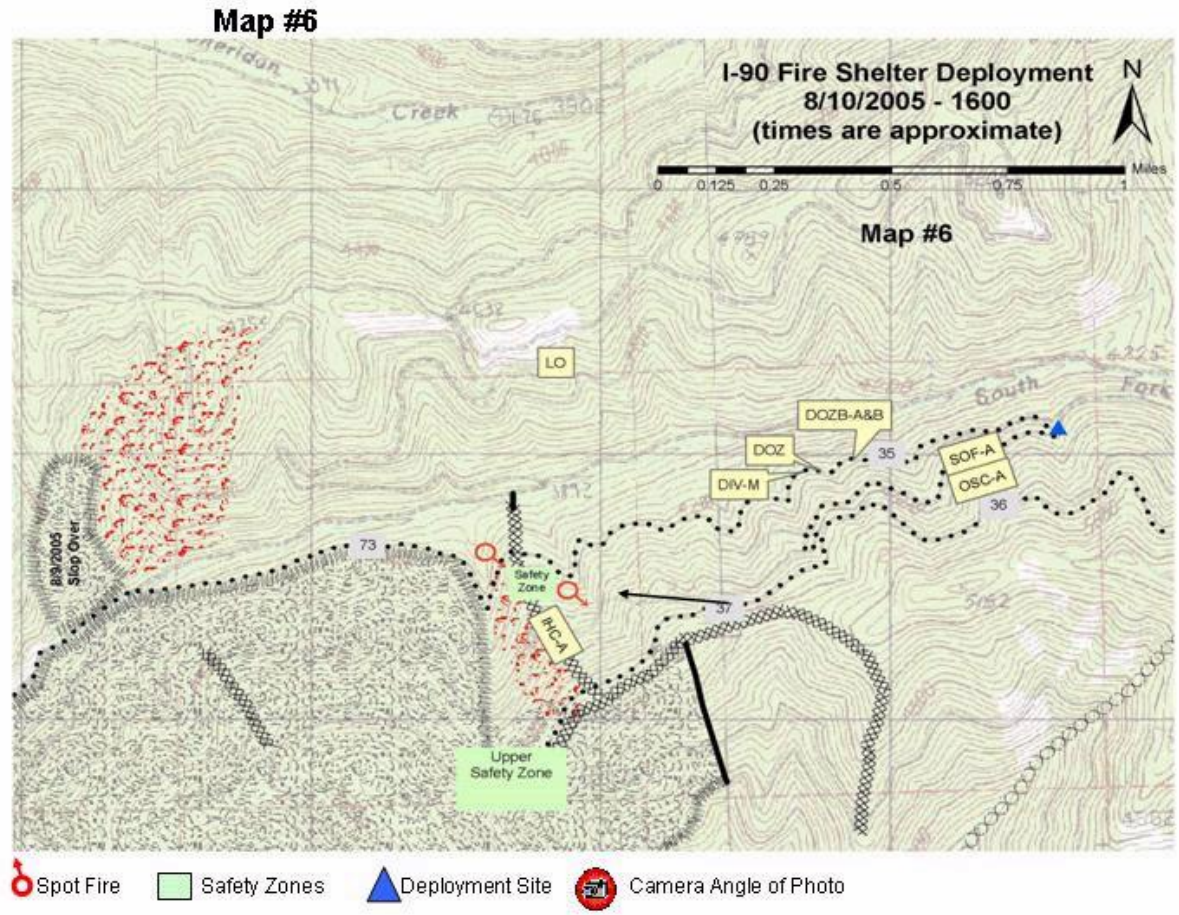


(Map 5)

By 1545 the slopover has a well-developed plume and is now established on the far ridge, moving east along the ridge. The Dozer and Dozer Bosses have moved up canyon one mile to where the slopover can be observed, assisting as a lookout for Interagency Hotshot Crew-A.

Division-M, Operations Section Chief-A, and Safety Officer-A are quite mobile during this period, and personally check the viability of the escape route to the Upper Safety Zone, and the Upper Safety Zone itself.

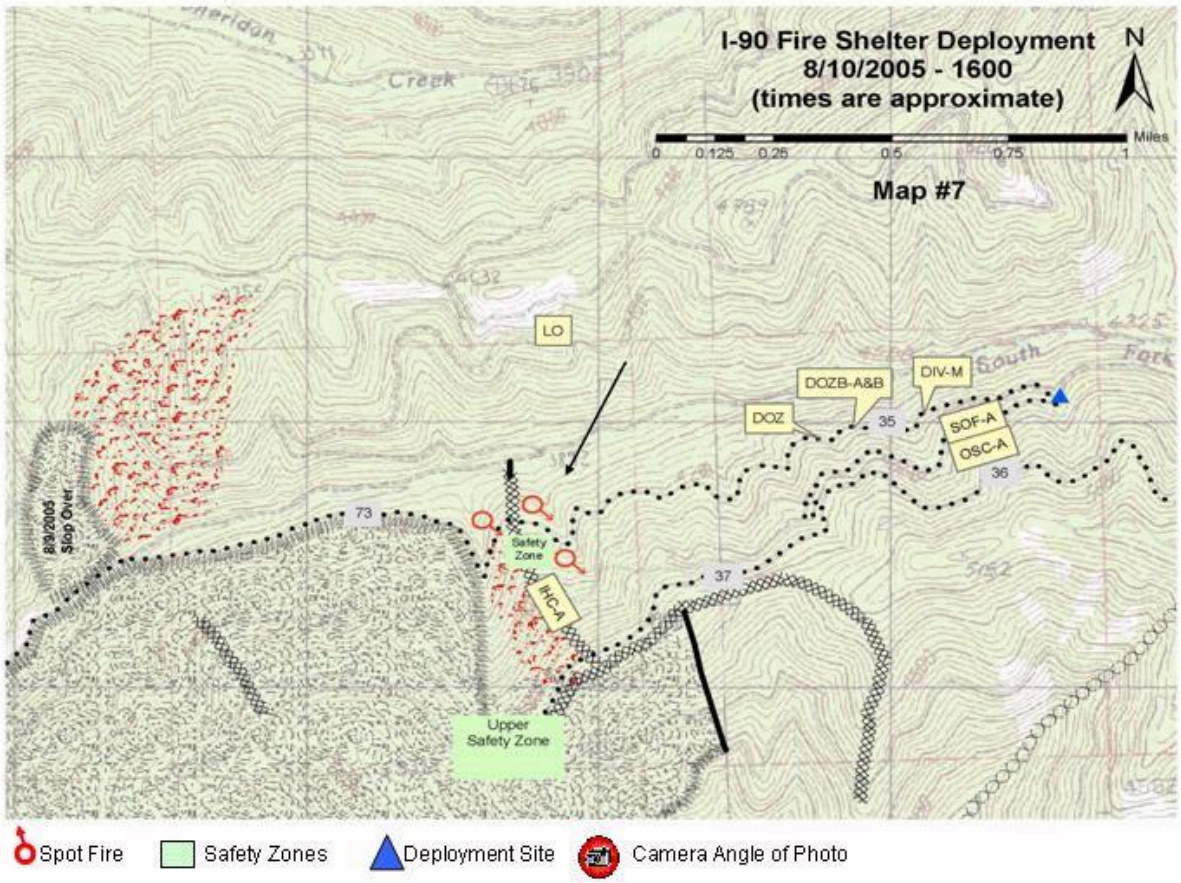
A spot fire is detected below the 35 / 73 Road, inside the contingency line at 1545.



(Map 6)

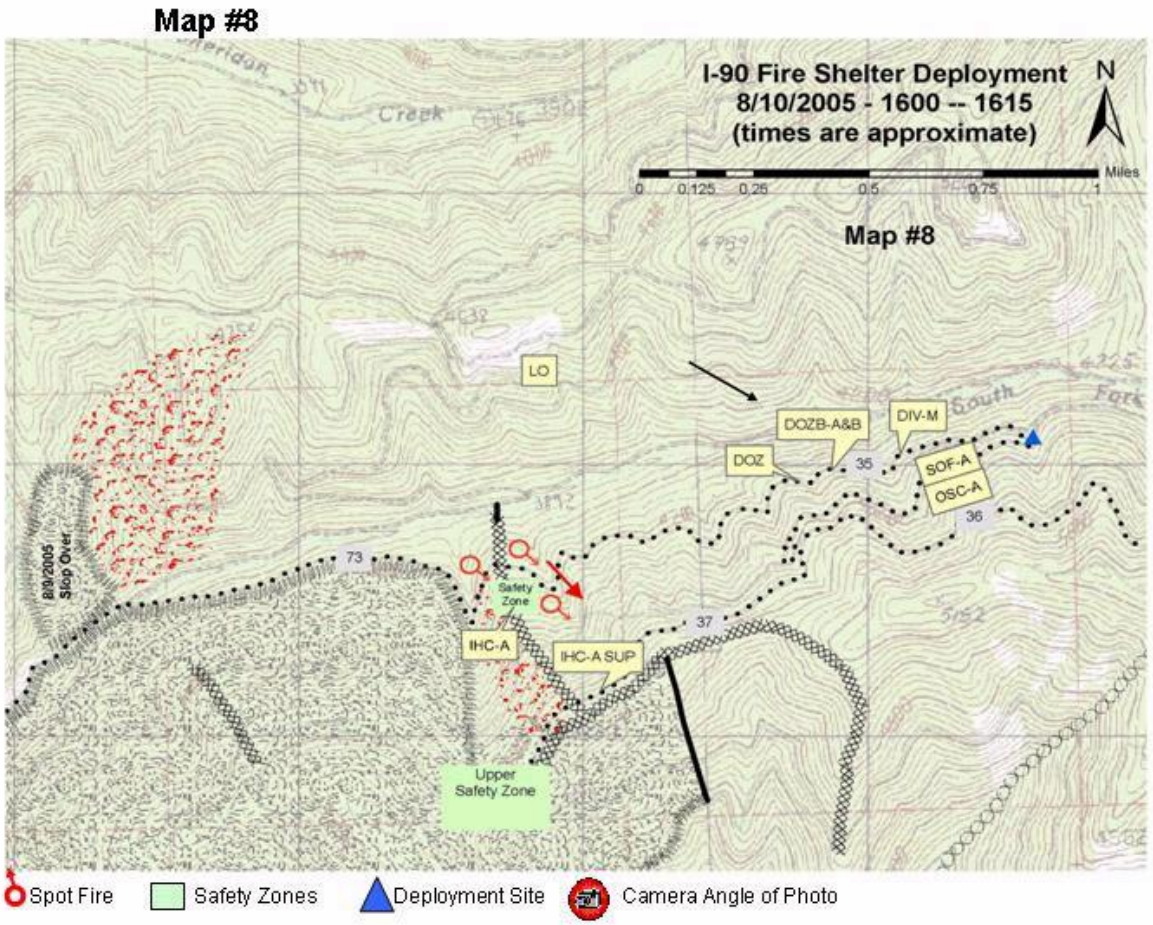
At 1600 another small spot appears above the road, outside the dozer line. With close proximity to the Lower Safety Zone, Interagency Hotshot Crew-A Supervisor dispatches two crewmembers to put it out. Operations Section Chief-A arrives back with the Dozer and Dozer Bosses, as well as Division-M. After short consultation, as Safety Officer-A arrives; Division-M orders resources to safety zones. Division-M orders resources assigned to the slopover to Drop Point-22, and orders Task Force Leader-A to take charge of those resources.

Map #7



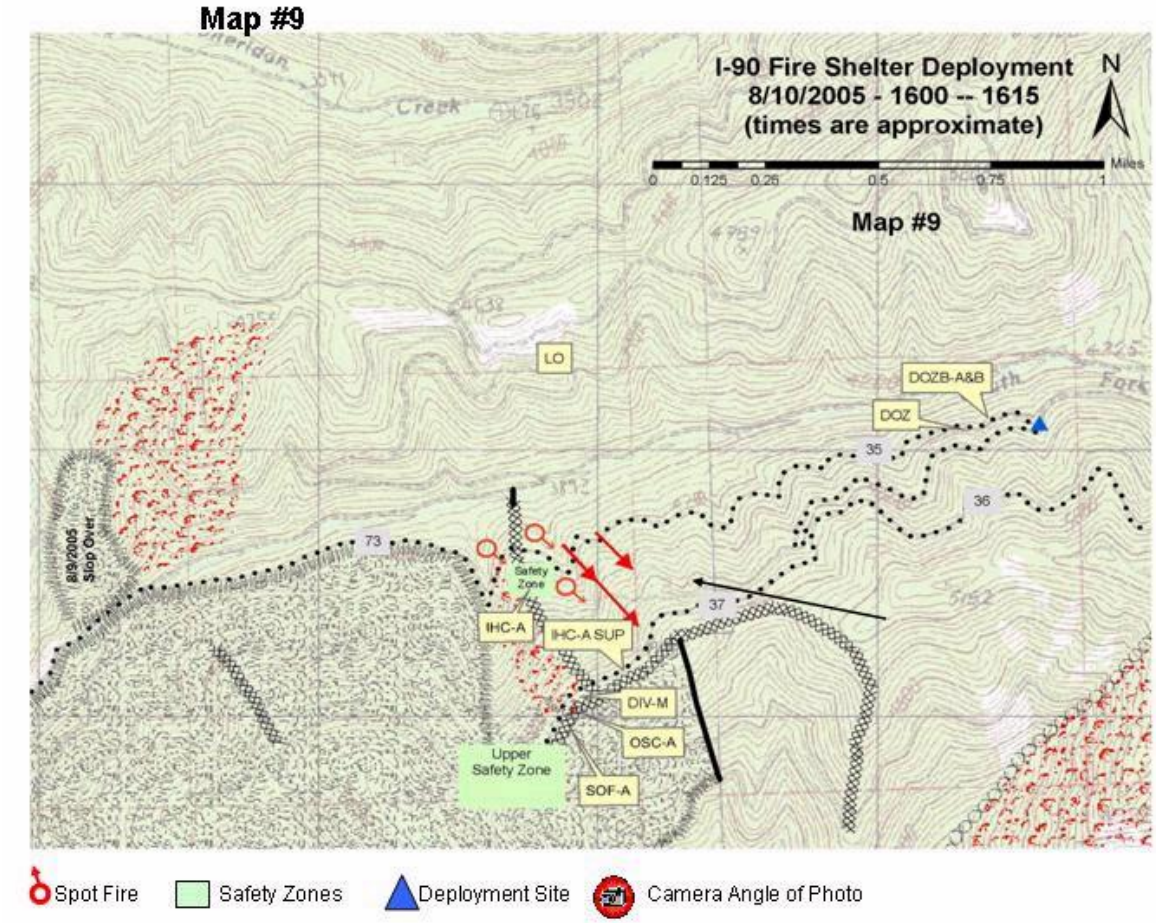
(Map 7)

Dozer Boss-A diverts a loaded helicopter with bucket to drop its load on a "new" spot below the road, outside the contingency line. He recognizes this spot as being 'in our backdoor" and a risk to their escape route. Ordered out again by Division-A, Dozer Boss-A says he would like to put one more load of water on the spot. He orders the helicopter to load and return.



(Map 8)

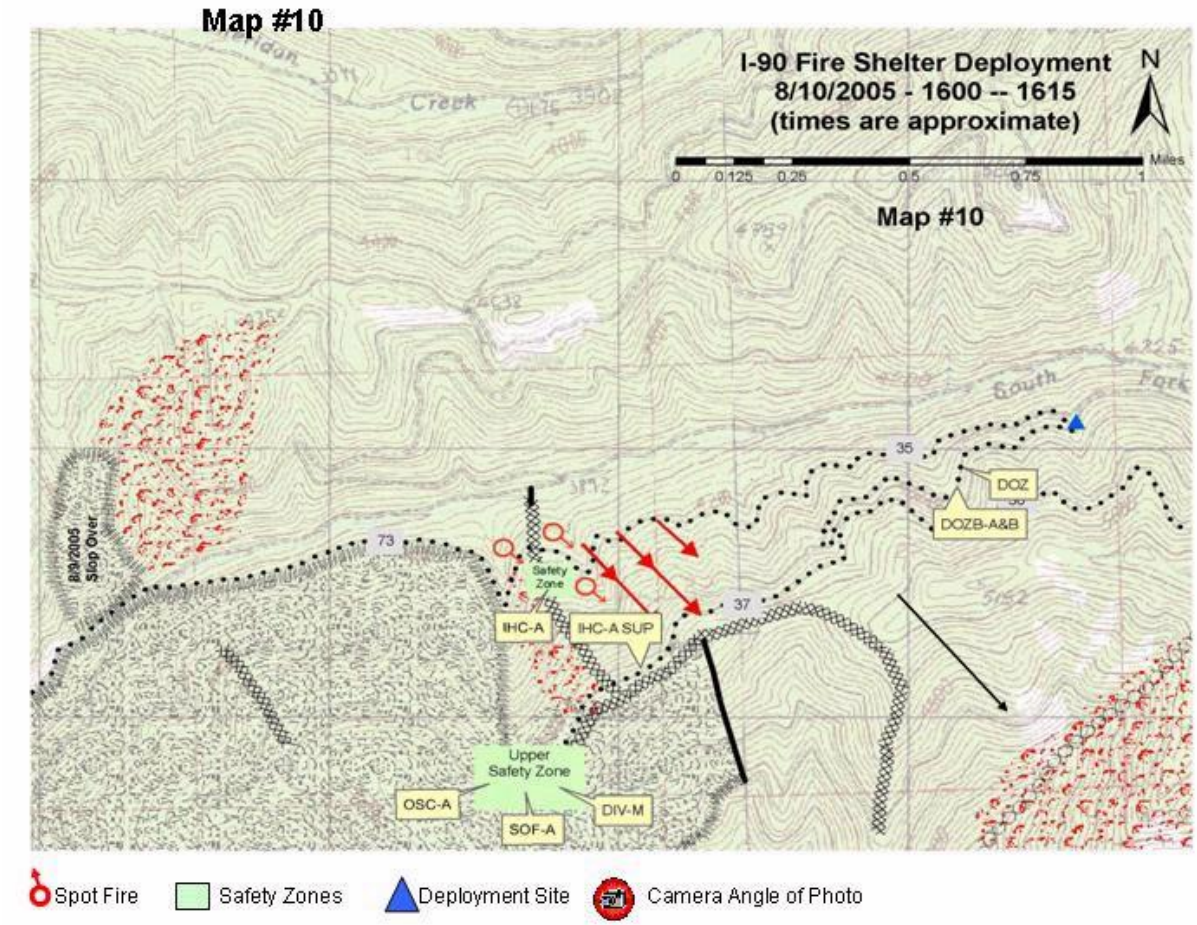
However, the helicopter does not return, and the Dozer, Dozer Bosses-A and B soon head out towards the Upper Safety Zone, closely following Division-M.



(Map 9)

At about 1615, as Operations Section Chief-A, Safety Officer-A and Division-M are driving towards the Upper Safety Zone, Interagency Hotshot Crew-A Supervisor, having moved his crew into the Lower Safety Zones has walked to the Upper Safety Zone and becomes a lookout from his position on the road at the top of the dozer line. He notices the spots are spreading fast, and additional spot fires have developed east of the dozer line and that the 37 Road leading to the Upper Safety Zone may become compromised. This is communicated to Division-M, Operations Section Chief-A, Safety Officer-A, and Dozer Bosses-A and B. Safety Officer-A, Operations Section Chief-A, and Division-M just make it to the Upper Safety Zone as the road behind them is cutoff by flames from the spot fires.

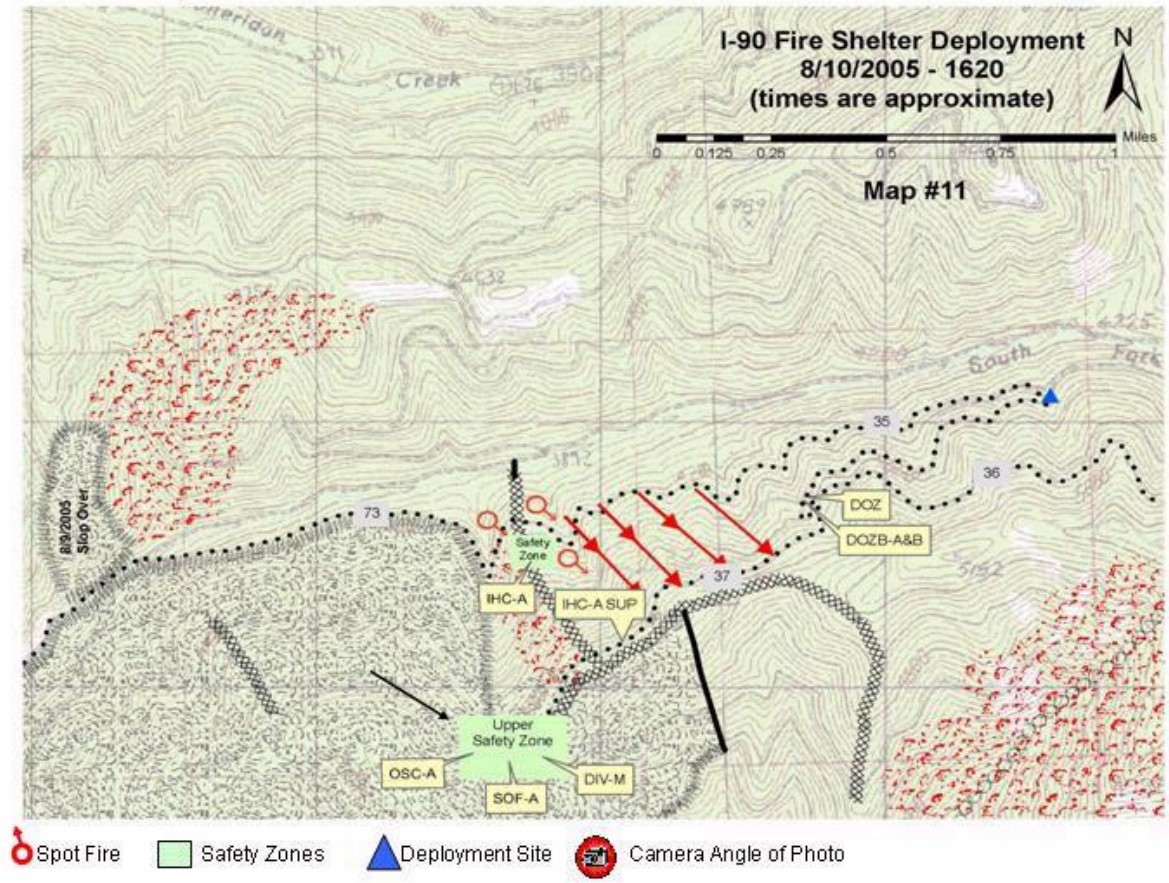
Reported times are not clear, but at about this time the Interagency Hotshot Crew-A lookout across the canyon withdraws.



(Map 10)

A radio discussion between Division-M and Dozer Boss-A covers a couple of options; as 37 Road is not an option, perhaps 36 Road out towards Division-H would work, but a smoke column is appearing above the ridge from Division-H. Division-M suggests abandoning the dozer and taking the operator with them in the pick-up out the 36 Road, but does not know the situation in Division-H.

Map #11



(Map 11)

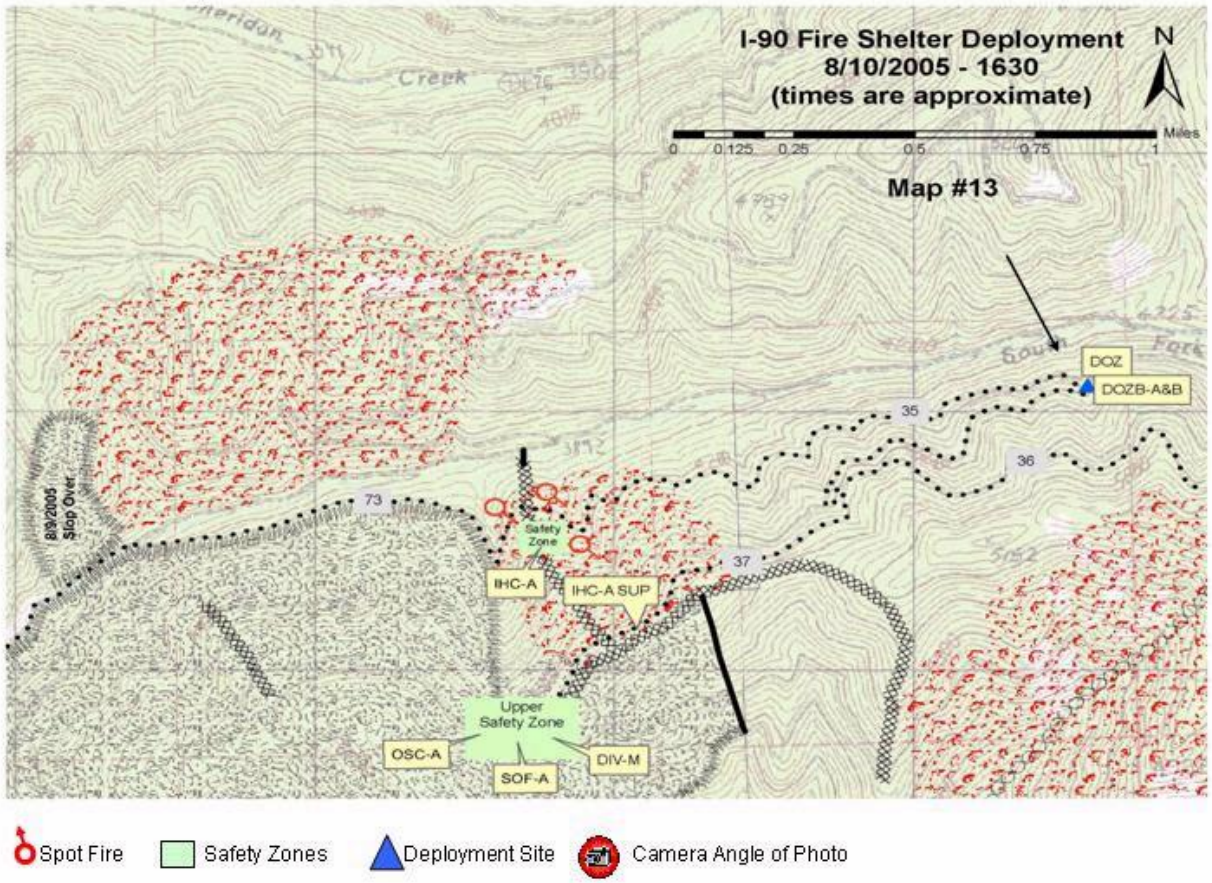
Operations Section Chief-A is right there with Division-M, and checks with Operations Section Chief-B. Operations Section Chief-B has first hand knowledge regarding the 36 Road, but knows Division-H is also experiencing active fire, and cannot tell them if the 36 Road is open.

Map #12, Photo #5

(Map 12 - Photo 5)

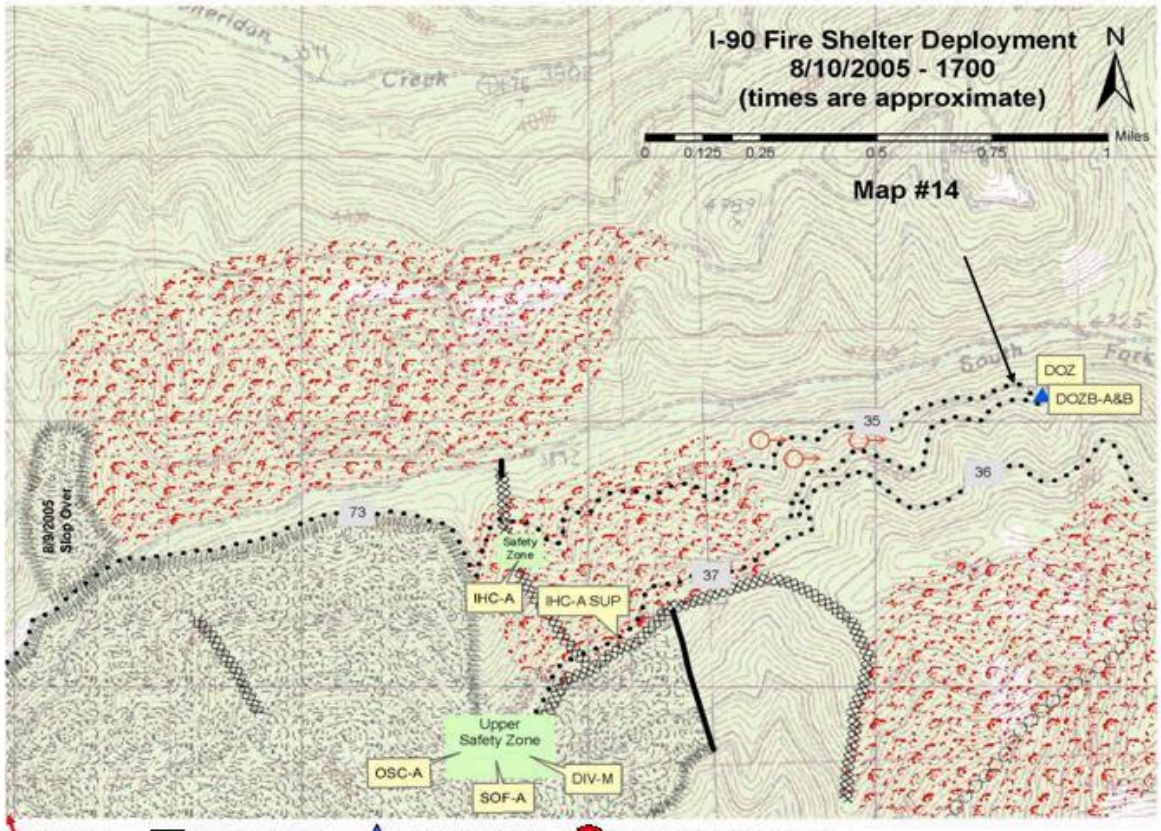
Dozer Bosses-A and B take decisive action, choosing to move themselves and the dozer back to the switch back junction. As the 36 Road is an unknown, they choose a known entity with high probability for success over an unknown.

Map #13



Spot Fire | Safety Zones | Deployment Site | Camera Angle of Photo

Map #14

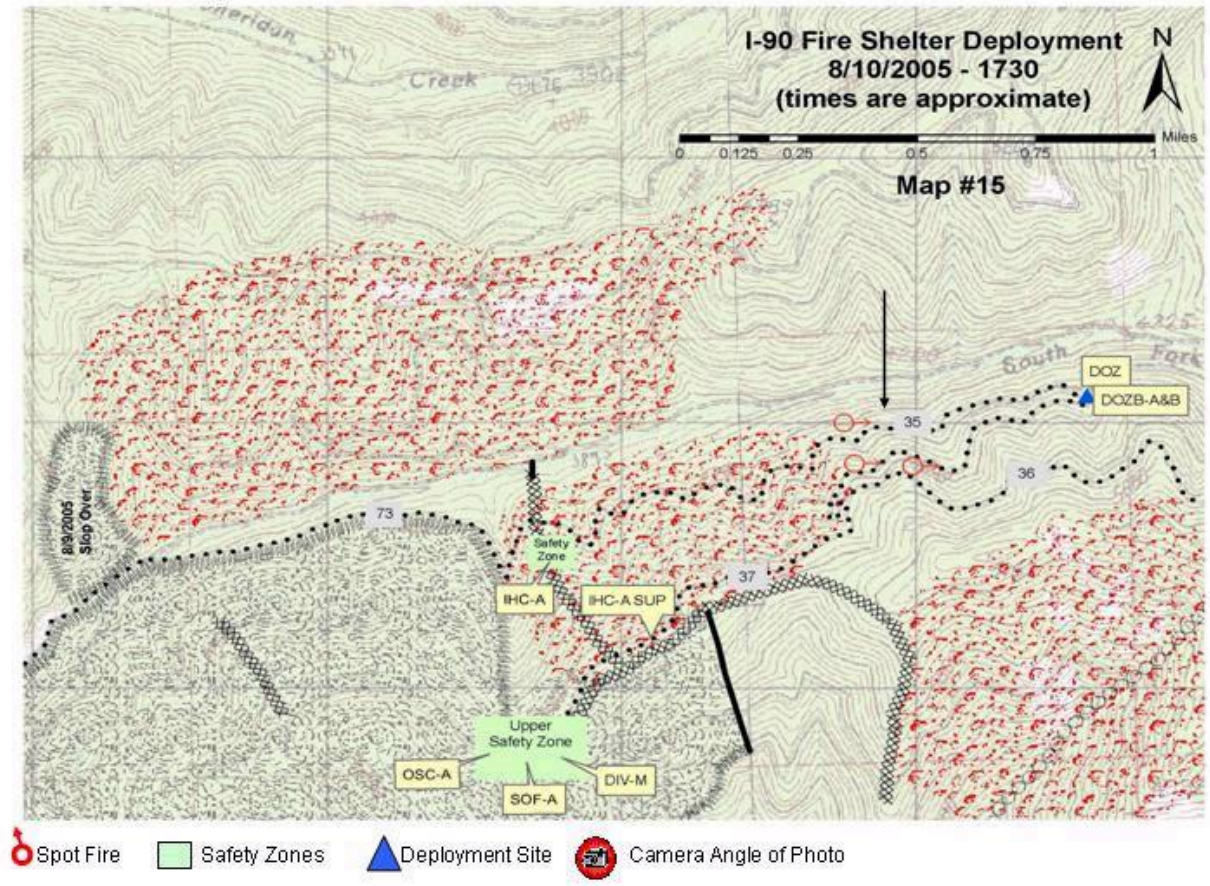


Spot Fire | Safety Zones | Deployment Site | Camera Angle of Photo

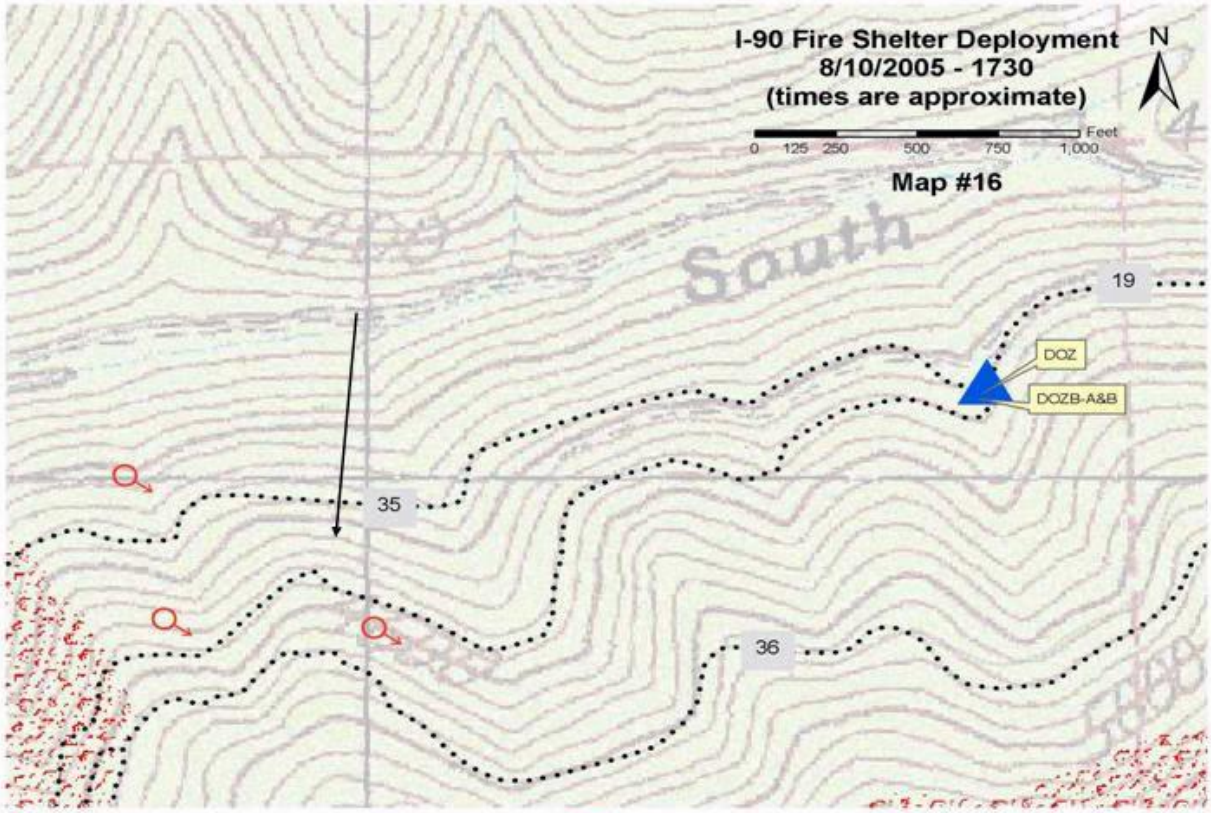
(Maps 13 and 14)

At 1630 all the resources from the slop-over are accounted for by Task Force Leader-A and Branch at Drop Point-22. Division-M further discusses with Dozer Boss-A the appropriateness of their alternate safety zone to ensure it is adequate. A few minutes later the Dozer is working to further improve the safety zone, including removing the fuel from the area between the roads, west of the switch back. (See safety zone detail.)

Map #15

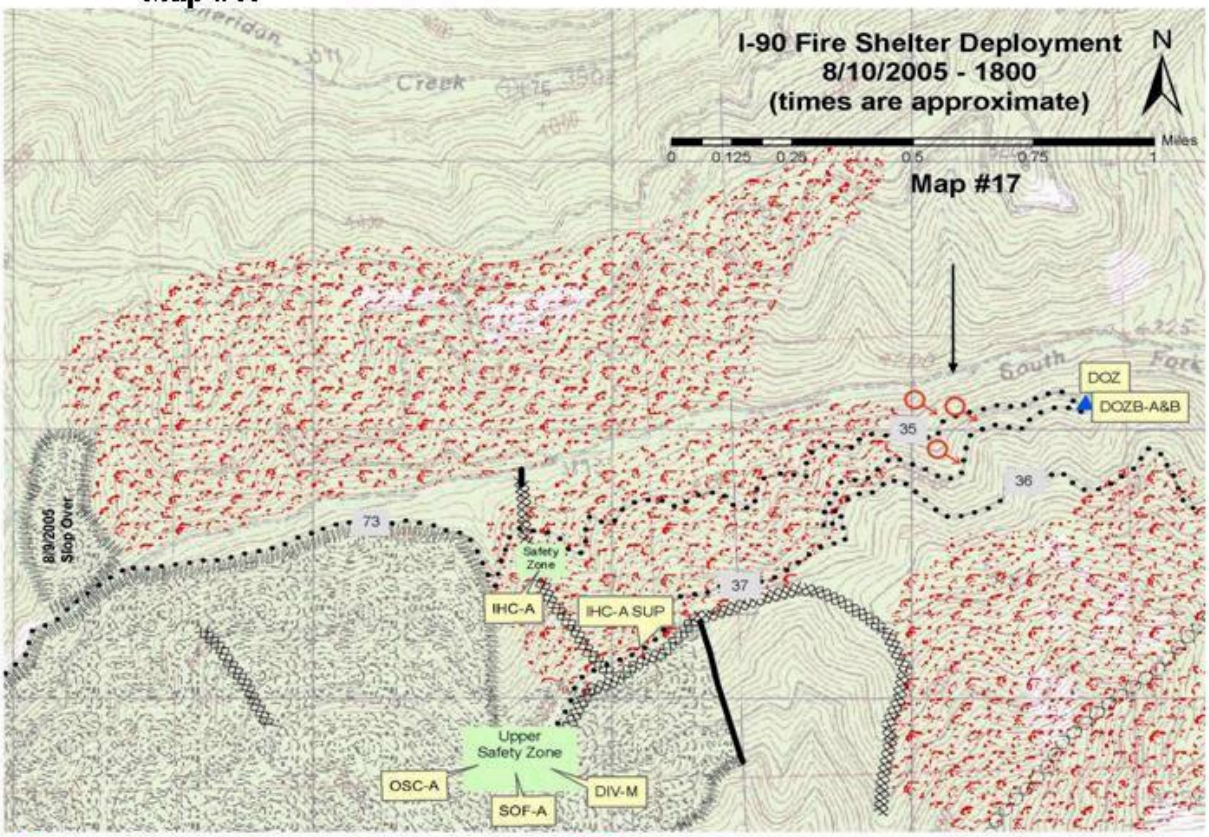


Map #16



Spot Fire | Safety Zones | Deployment Site | Camera Angle of Photo

Map #17



Spot Fire | Safety Zones | Deployment Site | Camera Angle of Photo

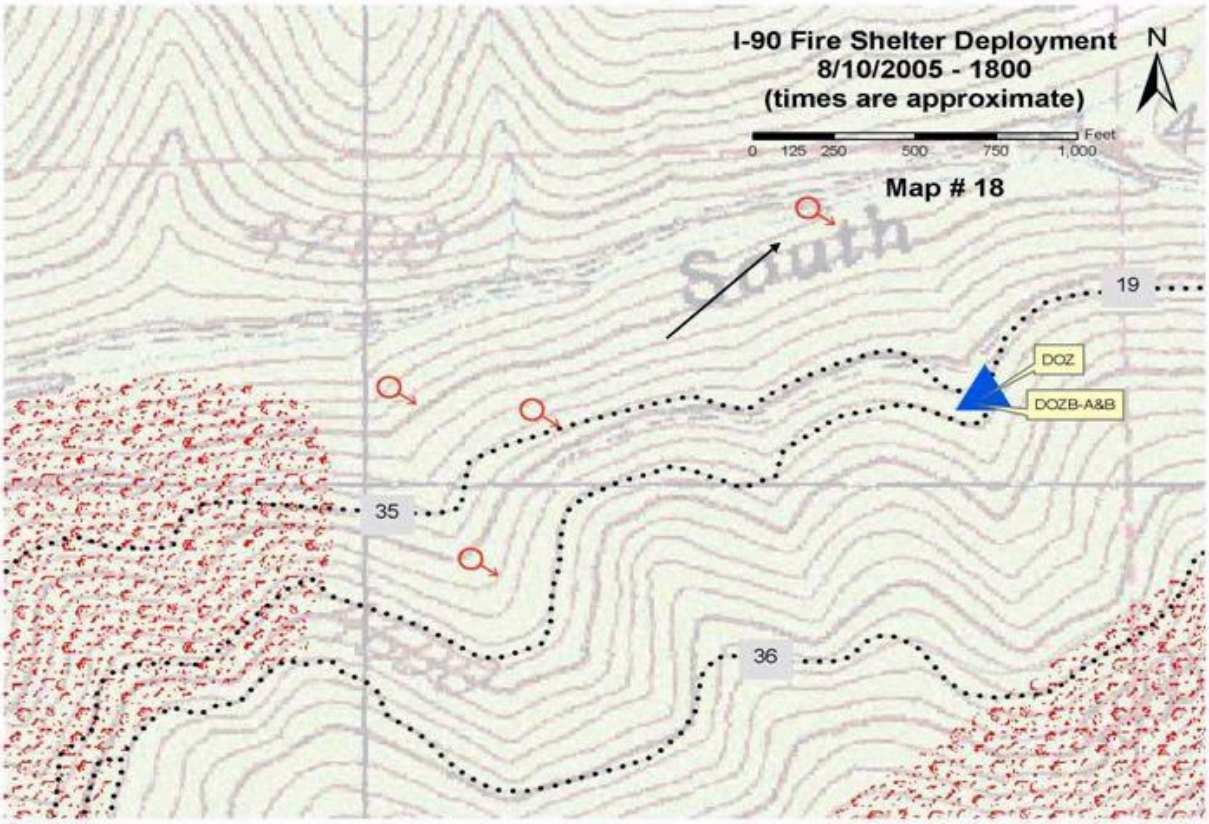
Photo #6 and Photo #7

(Maps 15, 16, and 17 – Photos 6 and 7).

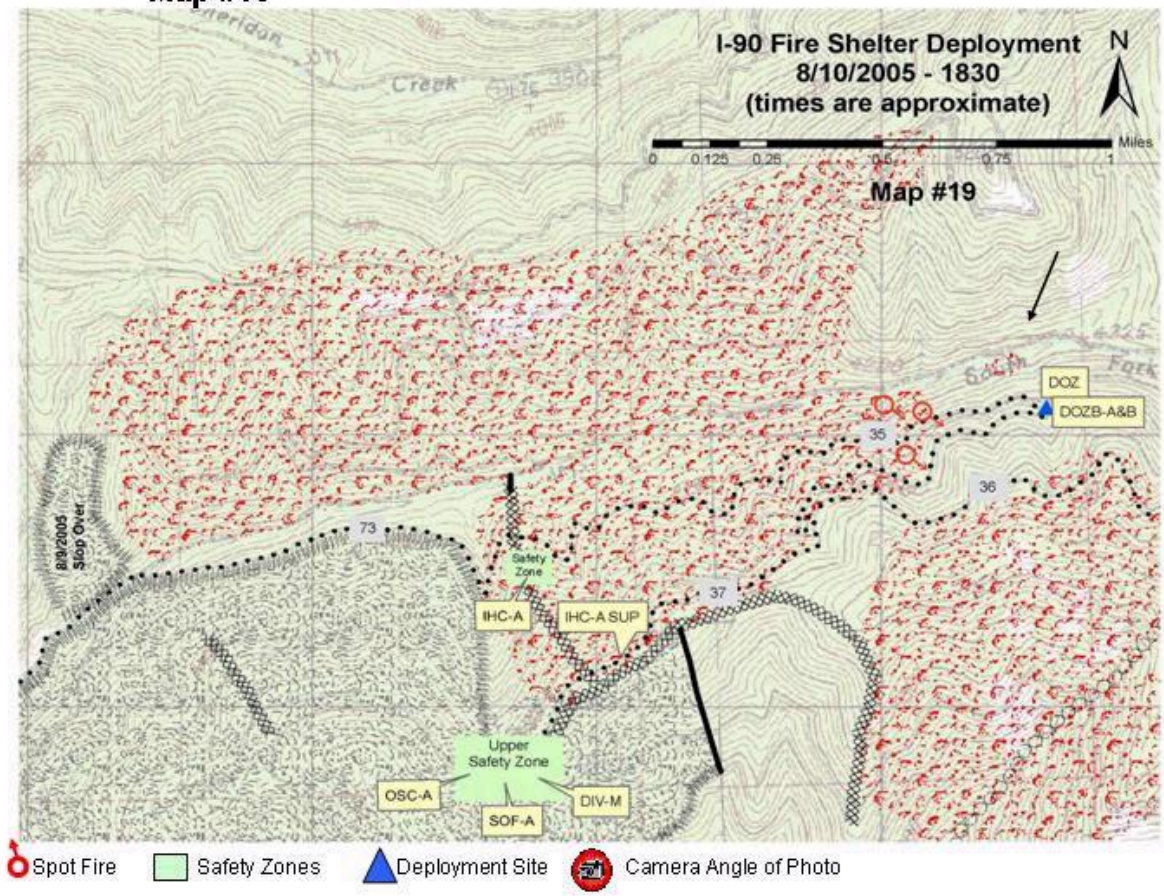
Operations Section Chief-A reports long range spotting in Division-M.

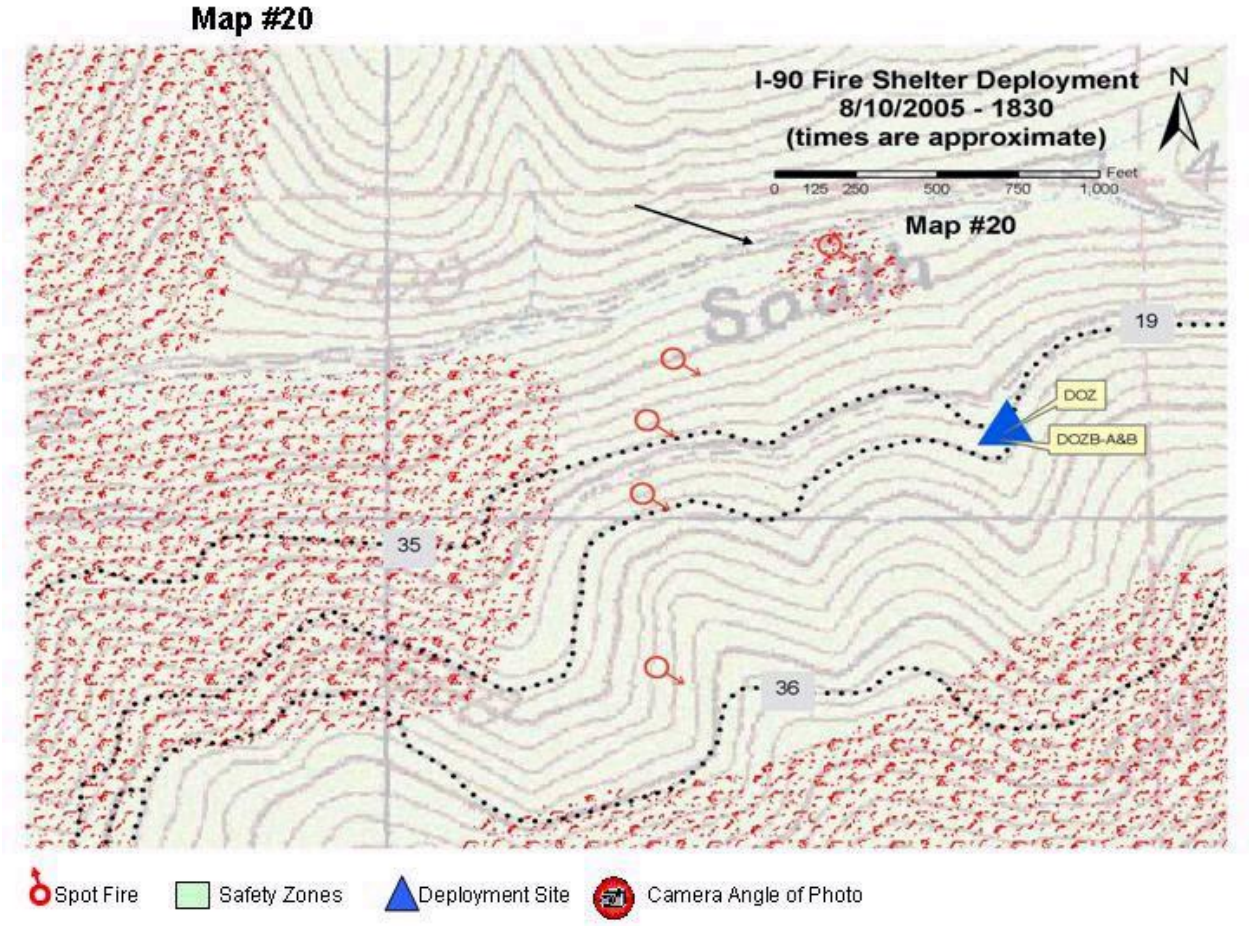
By 1730 discussions at the Operations Section Chief / Branch level consider establishing an anchor at the heel of the slopover and going to work, but they determine conditions are too dangerous. The slopover across the drainage has a full head of steam, proceeding east, along the ridge (Photos 6 and 7).

Map #18


I-90 Fire Shelter Deployment
8/10/2005 - 1800
(times are approximate)
N
0 125 250 500 750 1,000 Feet
Map # 18
South
19
DOZ
DOZB-A&B
35
36
Spot Fire
Safety Zones
Deployment Site
Camera Angle of Photo

Map #19


I-90 Fire Shelter Deployment
8/10/2005 - 1830
(times are approximate)
N
0 0.125 0.25 0.5 0.75 1 Miles
Map #19
Creek
South Fork
DOZ
DOZB-A&B
35
36
37
73
8/9/2005 Slop Over
Safety Zone
IHC-A
IHC-A SUP
Upper Safety Zone
OSC-A
DIV-M
SOF-A
Spot Fire
Safety Zones
Deployment Site
Camera Angle of Photo



(Maps 18, 19, and 20)

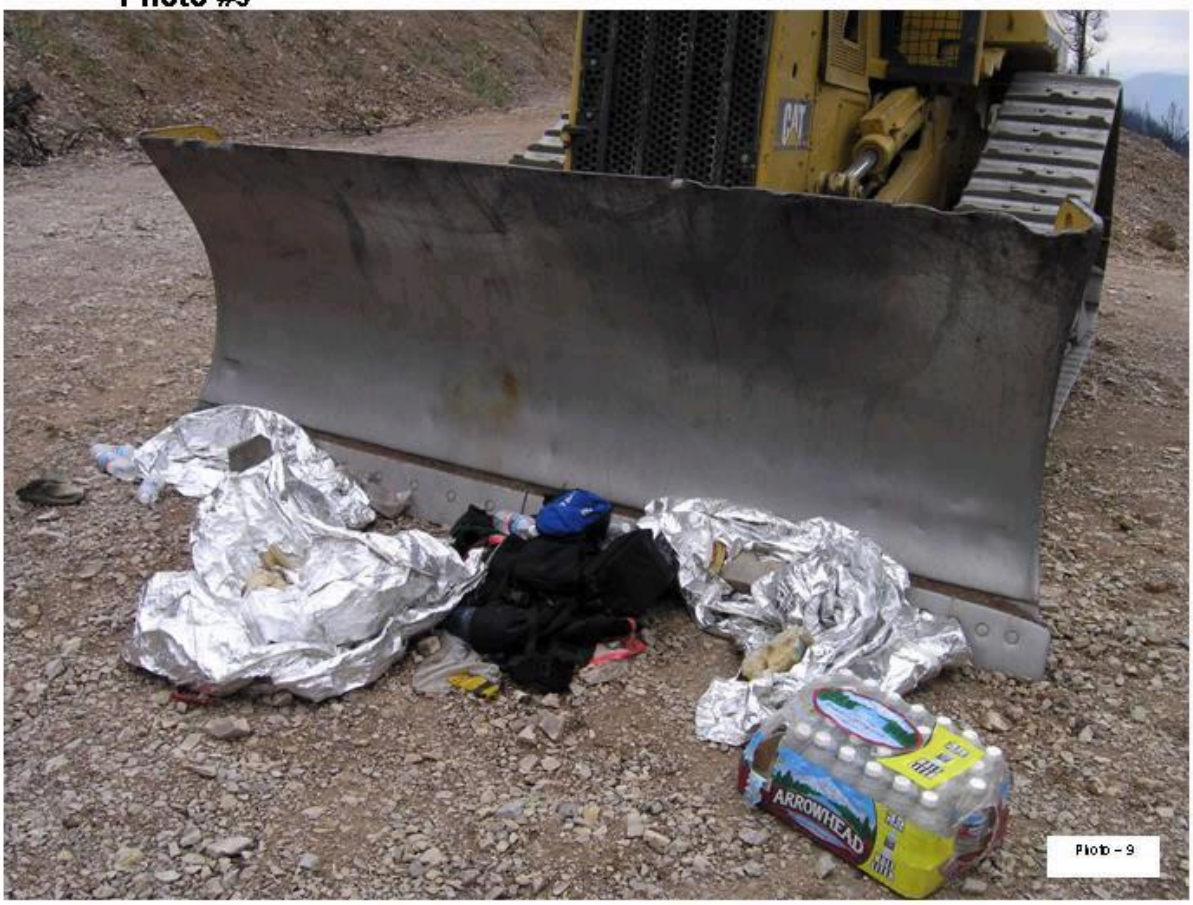
By 1800, a spot appears in the drainage directly below the alternate safety zone.

Photo #8

(Photo 8)

The dozer is placed in the middle of the safety zone and the pickup is placed up canyon from there.

Photo #9



(Photo 9)

Line gear and a case of drinking water are staged forward of the blade.

Photo #10

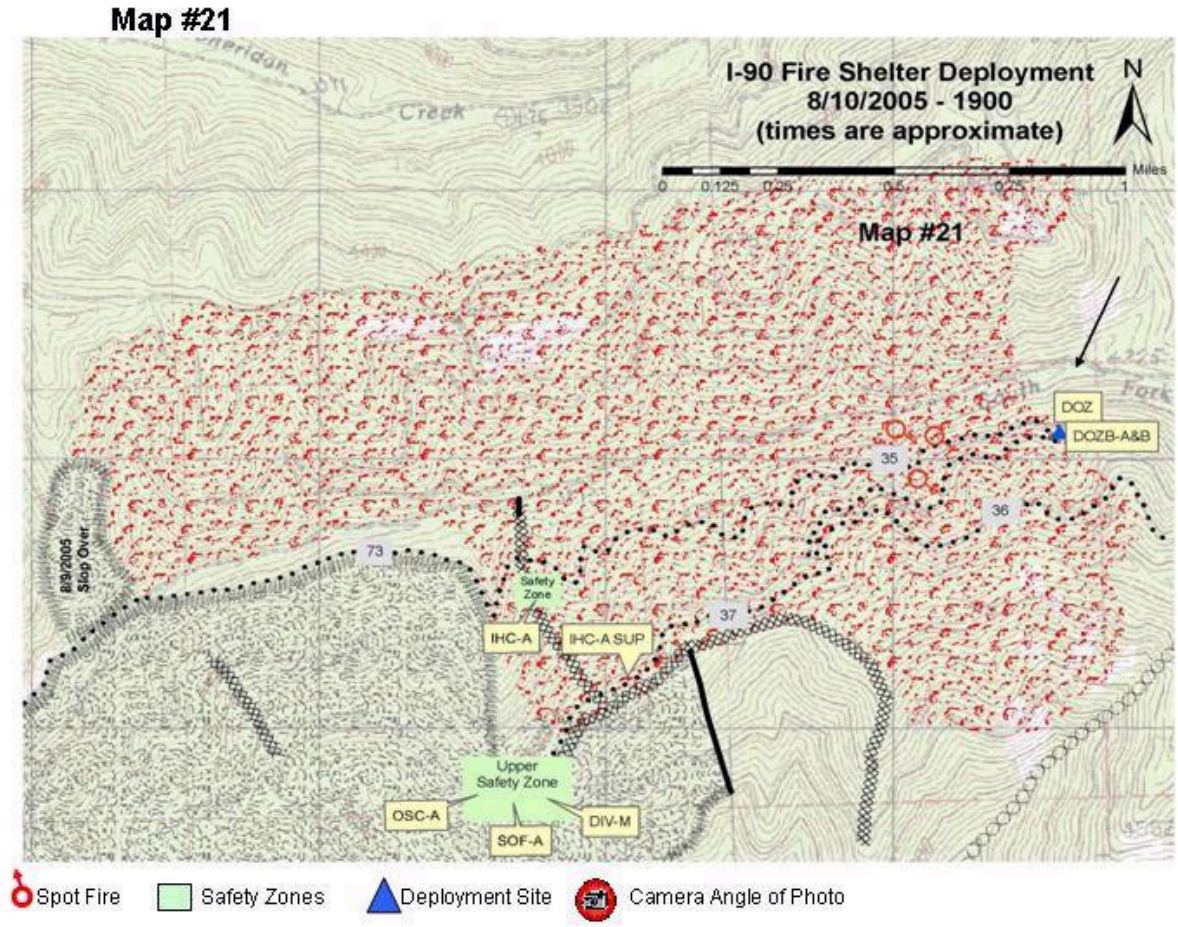
Photo #11

(Photo 10 and 11)

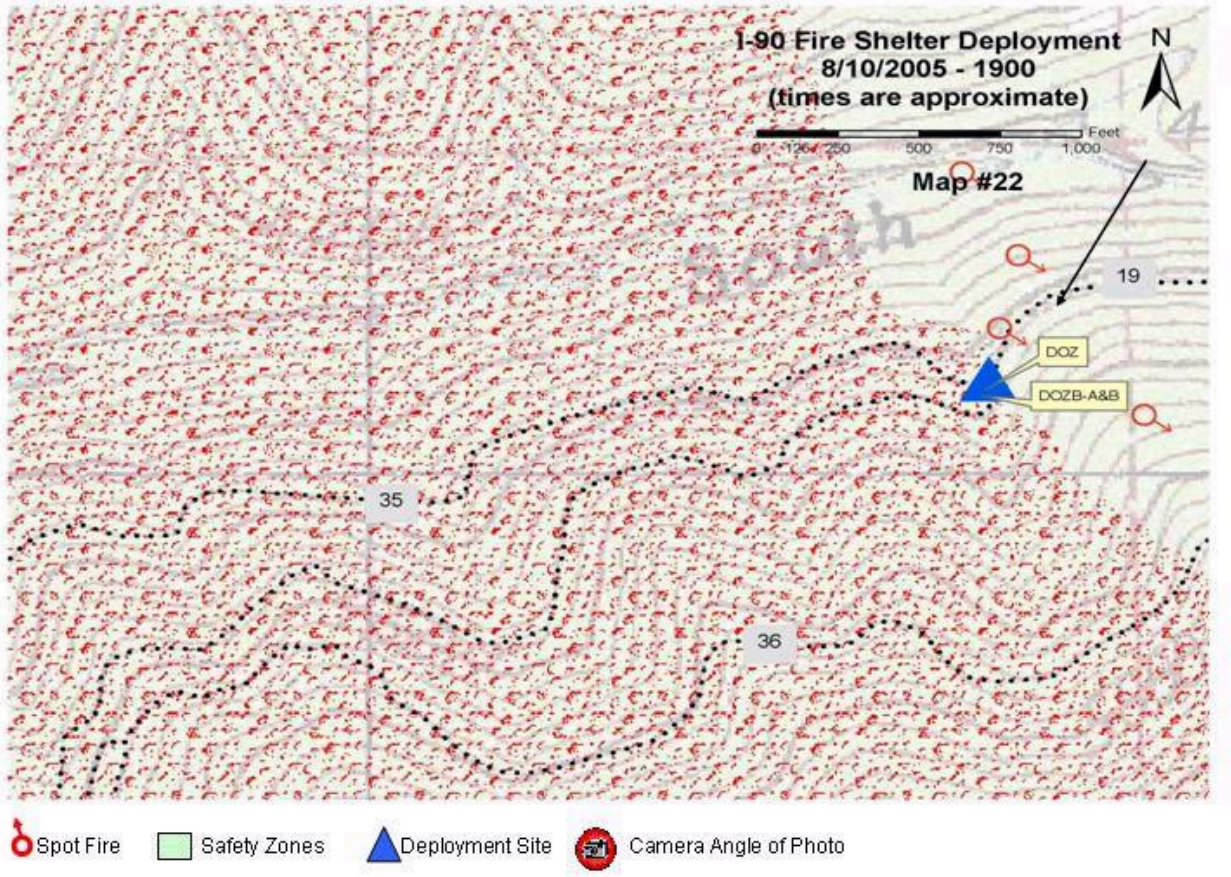
Fusees are dispersed down the road to the east.

They have removed their packs and other flammables from the pickup bed and placed them along the cut bank, down-wind, to eliminate flammables in the bed of the pickup (remnants of packs – Photo 11).

They have discussed the need to deploy shelters, and based on the fire behavior previously experienced think they will probably not need them. Notice however, the shelters are close at hand with their line gear.



Map #22



(Maps 21 and 22)

The three are in the alternate safety zone for over 2 hours. Fire behavior is active to be sure, but has not reached peak intensity. At 1850 they are crouched in front of the blade. Close to 1900 the fire reaches the alternate safety zone. It has also moved up-canyon to that same point on the north side. Conditions at the alternate safety zone get quite exciting, with flame reaching from the west side all the way over the dozer, 20 feet above their heads (~110 to150 feet horizontal flame length). Small trees snap off in the canyon below and a rain of embers pelts them from all angles. The embers are becoming unbearable when the radiant heat from the fire above the cut bank makes it obvious it is time to shelter-up, and Dozer Boss-A gives the order.

Deployment was smooth, with the exception of one firefighter looking for the shelter's side seam instead of grabbing the shake handles provided in the new shelter design, causing a momentary hitch for one firefighter.

They are in the shelters for a few minutes, with temperatures inside the shelter getting "sauna like" warm. An orange glow shows through the seam stitching holes. After the first couple minutes, they are lifting the edge of the shelter to allow cooler air in.

By 1910, heat and embers have cleared and all three are out of their shelters. Five minutes later they call Interagency Hotshot Crew-A Supervisor to inform him they have deployed shelters and

that there are no injuries. Knowing the significance of a deployment, they began documenting the event.

The shelters show no heat damage, nor do the dozer or pickup truck. The shrink-wrapped plastic on the staged drinking water next to them shows no heat damage, nor the worn plastic wrap on the dozer seat, approximately six feet off the ground. The light bar on the truck, also over 6 feet above the ground, does not show any damage. An empty water bottle in the bed of the pickup shows melting, but appears to have been melted when an ember ignited a ball cap in the bed. Moving away from the center of the alternate safety zone, east down the 19 Road, indicators of more heat become apparent, with melted bottles at 100 feet, and the flagging used to close the road, melts and blows onto the cut-bank. The nearby fusee does not ignite, but the packs burn completely. (See Photo 9 from previous.)

Photo #12

Photo #13

Photo #14

(Photos 12, 13 and 14)

These 3 photos show the vegetation frozen in the direction of hot gas flow.

By 2030 Division-M, Operations Section Chief-A, Safety Officer-A and an Emergency Medical Technician and Sawyer from Interagency Hotshot Crew-B arrive to offer assistance. The three are in good shape, and they all proceed to the Upper Safety Zone where an After Action Review (AAR) is conducted.

They return to Drop Point-22 (Church Spike Camp) at 2315. The dozer operator leaves for home, and Dozer Bosses-A and B arrive at Incident Command Post at 0130, where they are again checked, by the medical unit.

Photo thumbnails images are at:
http://www.fs.fed.us/r1/fire_r1/shelter/batch/index.htm