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UNITED STATES GOVERNMENT

Memorandum

Department of Agriculture---Forest Service
Washington, D. C. 20250

TO : Regional Forester, R-5

File No. 5100

FROM : Merle S. Lowden, Director
Division of Fire Control

Date: November 29, 1966

SUBJECT: Fire Control Training, 1967 National Fire Behavior Course

Your reference: Our ref 11/10

The close relationship of Fire Behavior to topography in connection with the Loop Fire tragedy makes this fire event a natural for development by Dick Johnson in his topic, "Topographic Effects Laboratories." Rather than the possibility each instructor might relate some portion of his presentations to the Loop Fire, we are restricting it to Johnson's lab assignment, and to some general references in my remarks on the last day of the course.

For this purpose, a copy of the Loop Fire Investigation Report is enclosed for Johnson's use.

Several colored slides assembled by the Investigating Team are being duplicated in order to provide Johnson with three sets for his concurrent lab sessions. They will be forwarded to him as soon as available.

Johnson should prepare a laboratory exercise based upon events leading up to the entrapment of the crew, and upon the Fire Behavior Team Report (made a part of the Investigation Report). Trainees should be given tangible (as though they were there) decision problems. We are sure Dick will prepare these to provide a framework which establishes the advantage of hindsight in reviewing what took place.

The team report itself is to receive only limited distribution. A summary for wider distribution will be made available to the field prior to the course. Copies of this summary report can also be available at the course for Johnson's use as a handout.

Enclosure

Merle S. Lowden

National Fire Behavior Training Course

Marana Air Park, Arizona

January 16-27, 1967

LOOP FIRE EXERCISE

OBJECTIVE: Upon the completion of the Loop Fire Exercise the trainee will be able to:

1. Recognize, in proper prospective, the various factors of fire behavior and the hazards they present in fighting fires.

2. Make decisions and take the proper action to fight fire "aggressively but safely" when faced with these hazards.

INTRODUCTION

On November 1, 1966, in a canyon near the boundary of the Angeles National Forest, a flare-up on the Loop Fire overran the Forest Service's El Cariso "Hot Shot" crew, burned to death 10 firefighters and inflicted critical to minor injuries on 12 others. Two of the critically injured have since died. Three members of this crew and a Forest Service Division Boss were not injured.

In presenting this tragedy as a training exercise we ask that each trainee carefully consider the facts as they are presented to you, apply all the knowledge of fire behavior at your command and add the benefit of hindsight of knowing what actually happened when arriving at your conclusions. In this way we will each gain the advantage of a second chance in making these vital decisions.

LOOP FIRE
ANGELES NATIONAL FOREST
NOVEMBER 1, 1966

CHRONOLOGY OF EVENTS

Cue (Figures 1-2-3-4 and Appendix E as reference material are attached)

11/1/66 - 5:19 AM (PST) Fire started

5:36 AM - Initial attack on Santa Clara Fuelbreak by one pumper and one patrol unit

Weather History

Fire danger in the San Gabriel Mountains was above normal much of the 1966 fire season. Six Santa Ana periods occurred during latter portions of September and October. The last period began on October 28 and the greatest intensity occurred on November 1, the day the fire started.
General Weather Forecast: Clear - Temp. 73° Humid. 12%
Wind NE 10 - fire plan 8 - extreme.

Actual Weather: Temp. and humid. as predicted. Wind 40 to 60 mph at origin, tapered off by mid-morning. E to NE 15 - 20 by mid-afternoon with some calm period.

6:00 AM - First reinforcements arrive. L.A. City and L.A. County notified. D.R. Jess Barton, Fire Boss. Masterson Line Boss. Westmoreland Division Boss east line. Plan to try and hold north and east sides of fire.

8:00 AM - Beaty relieved Barton as Fire Boss. Barton not qualified as Class I Fire Boss. (Figure I)
Show Transp. I
Beaty and Masterson have determined that:

1. West side of fire was approaching an area burned in 1962.
2. South side of the fire would be taken care of by L.A. County and City Fire Departments.
3. All F.S. effort was to be expended on the north and east sides of fire.
4. Beaty cautions Masterson to cold trail and "keep one foot in the burn."

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The north edge of the fire was held on the Santa Clara fuelbreak from pre-attack plan A-42 east to pre-attack plan A-30 (Figure 2). A tractor line was constructed to A31 and held. Control on the remainder of the west perimeter was obtained

0830 AM - The fire weather forecaster issued the following special forecast for the fire area -

"Loop Fire
Santa Ana conditions with winds NE to E 30, gusts to 50, decreasing this afternoon and Wednesday. Maximum temperature 95, minimum relative humidity 10 percent."

Northeast winds continued throughout the day. Wind speeds were high during the early morning and the forenoon. In the nearby San Fernando Valley, winds of 24 to 28 mph were recorded at 4 AM and from 13 to 36 mph at 1 PM. One report from the fireline said the gusts were "strong enough to blow a man down if he did not brace himself."

Winds decreased during the afternoon but remained from the northeast. Fixed-wing aircraft and helicopters were able to fly. On the east side of the fire, a northeast wind of only 8 mph with gusts to 12 mph was measured at 2:30 PM. There was considerable channeling of the wind and eddies were caused by the topography.

Temperatures at lower elevations were in the 90's and at higher elevations in the 70's or low 80's. Relative humidity was 10 - 15 percent. Fuel stick moisture percents were 3.0 to 4.0. Ignition Indexes1/ varied from 76 to 93 which meant that almost every firebrand could start a fire in light fuels. Burning Indexes1/ were "Extreme."

Topography

The lower Pacoima Canyon area consists of steep and broken topography. The gullies have steep, almost sheer, side walls. The fire started near the Los Pinetos Nike Site at about 4,000 feet elevation and burned downhill to about 1,500 feet behind the caretaker's residence at Pacoima Canyon Dam.

The disaster site was about 200 feet elevation above the canyon bottom and 1,000 feet below the main ridge.

Slopes in the chimney varied from 60 to 95 percent. Loose rock made foot travel extremely difficult and hazardous.

1/ As described in the Wildland Fire Danger Rating Handbook used by California fire agencies.

Fuels

Fuels in the lower Pacoima Canyon area were sparse and consisted chiefly of chamise, sage and sumac. Fuel loading in the main canyon was about .49 pounds per sqaure foot (about 11 tons per acre) which is considered light to moderate. The moisture of live chamise in Pacoima Canyon on November 1 was about 60 percent which is near the minimum possible for this species.

Sumac and very heavy litter were the most important fuel involved in the accident. The fuel loading was 1.60 per square foot or 35 tons per acre at the lower end of the chimney canyon. There are indications that fuel in the chute burned in about 4 minutes which means that flame temperatures where the men died were probably 2,500° F. or higher.

Fire Behavior

Fire behavior at the Loop Fire was typical of fires starting under Santa Ana conditions. From its origin, the fire was driven by strong northeast winds downhill toward the lower front country.

By early afternoon the fire had become established near the mouth of Pacoima Canyon. Under the slackening Santa Ana wind the fire backed downslope against the prevailing wind. Burning material rolling down the steep canyons occasionally caused small "fish hook" runs. The fire was being held with little difficulty along the county bulldozer line.

Show Slide I

Mid-morning - 1. Fire Boss Beaty noticed wind slacking off and ordered a lead plane and 5 air tankers to work on east line and slow spread to the east.

Show Slide 2

2. Beaty appointed Hite as Liaison Officer with L.A. County forces.

3. Masterson and Westmoreland with Chilao Hot Shot Crew and 2 County crews building line on east edge of fire moving south from Nike Site.

12:00 Noon - Dalton Hot Shot Crew arrived at fire.

1:00 PM - 1. With the exception of a few slop-overs, the fire was holding on the east line from the Santa Clara Ridge A-42 to a point about 40 chains below Contractors Point (A43) or about to A-45 (Figure 2).

Show Transp. 2

Show Slide 5

2:00 PM - 1. Hite arrives at L.A. County command post at SE corner of fire in Pacoima Canyon. (Slide No. 6)

2. County crews are approaching the SE corner with their line.

2:30 PM - El Cariso Hot Shot Crew Foreman King contacted Masterson at Contractors Point (A43) for instructions. Some but not all of the things King was told are (modified for exercise purposes).

1. Told to "leap-frog" Del Rosa Crew and cold trail fire edge if possible; mention was made of the steep terrain beyond point A-45 where the Del Rosa Crew was working.

2. Masterson pointed out that there would be lots of rocks rolling and there might be a few runs.

3. Masterson mentioned that the "main ridge" (A-45 to A-47 but not identified to King as such) could be used as alternate if it was impossible to follow the burned edge.

There was no Angeles Forest radio available for King and El Cariso Crew as Del Rosa Crew had taken last radio. The crew left their fire shelters on the truck and their fire resistant shirts had worn out and were not replaced prior to this fire call.

Loop Fire Exercise No. 1

1. Based on the information you have available:

   a. Write the briefing instructions that you would give to King for his assignment.

b. List the factors of fire behavior that should be included in this briefing in the order of their importance.

Loop Fire

Angeles National Forest

November 1, 1966

Loop Fire Exercise No. 1 - Solution

1. Your briefing regarding assigned area should have included:

   a. History of fire to date including status of control.

   b. Location of fire - topography - fuels

   c. Situation - fire behavior - weather - values at stake

   d. Plan of action - including alternate plans

   e. Size and location of job - method of operation (strategy and general tactics)

   f. Safety precautions - general and specific dangers including the obvious dangers, such as fire behavior

   g. Alternate communications plan in lieu of radio

2. You should have included factors of fire behavior in briefing in order of their importance:

   a. Topography - chimney canyon, rock bluff - south aspect

   b. Fuels - light - dry - flashy

   c. Weather - high wind velocity, high temperatures, low humidity, low fuel moisture, ignition and burning indices high.

   d. Current and expected behavior of the fire.

Just because another man is recognized as an expert fireman you should not consider it an insult to his ability to brief him on each important item no matter how obvious they may seem to you.

LOOP FIRE

CHRONOLOGY OF EVENTS - CONT. 1

Cue

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Transp. 2
Show
Special
Slide 5
Show
Slide 9

2:35 PM - King and his assistant Burchett led their crew to point A-45 (Figure 2) as instructed by Masterson. They held the crew at a small bench below this point (point a, Figure 3) until King decided that it was possible to "cold trail" the fire down into the "chimney" canyon.

King could see the County tractors and crews working the lower edge of the fire eastward toward the lower end of the deep canyon immediately west of the "chimney" canyon and believed he could tie in with them.

Loop Exercise No. 2

At point a (Figure 3) King had to make a decision on which way to go.

a. List the items that are in favor of cold trailing down the "chimney" canyon.

b. List the items that are not in favor of cold trailing down the "chimney" canyon.

c. Describe what hindsight decision you would make at this point, telling what of the information you have been given influences your decision.

Loop Fire

Angeles National Forest

November 1, 1966

Loop Fire Exercise No. 2 - Solution

a. Items you could have noted in favor of cold trailing down "chimney" canyon:

1. Relatively short distance to construct line.

2. Fire backing downslope against prevailing wind.

3. L.A. County crews and equipment working at bottom of line with probable tie-in.

4. Alternate plan (ridge A-45 - A-47) would include more acreage, longer line construction, and burnout.

b. Factors you could have noted not in favor of cold trailing down "chimney" canyon:

1. Steep terrain with rocky face and chimney.

2. You were provided no information on advance scouting - no assurance that crew could "keep one foot in the burn" all the way.

3. No provision for any type of communication with cooperator crews or F.S. liaison at base of slope.

4. Alternate plan (ridge A-45 - A-47) was easier, safer terrain even though it would require burnout or backfire to complete line construction.

c. Use alternate plan ridge (A-45 - 47) as already determined in the pre-attack plan. This decision should include splitting crew and sending one-half of crew down ridge to work backup from an anchor at bottom. Dispatch runner back to Del Rosa crew to get advice to Westmoreland (Division Boss) and to Hite (Liaison with L.A. County) of action taken and plan to fire line A-45 to A-47 when line completed and tied across bottom to L.A. County cat line.

LOOP FIRE

CHRONOLOGY OF EVENTS - CONT. 2

Cue

2:45 PM - Line Boss Masterson requested Westmoreland (Division Boss who was equipped with a radio) to go down the east line to make sure the crews were lined out. Westmoreland checked each crew and caught up with the tail end of the El Cariso crew on the point on the ridge (point a, Figure 3) where the fire line descended into the chimney canyon. Division Boss Westmoreland was unable to directly contact King because King was already well down in the canyon and did not have a radio.

Show Special Slide 5

Show Slide 7

3:00 PM - King led the first units of his crew carefully down and across a steep, rocky face along the edge of the fire where a "fire retardant" line had been established by air tankers. Division Boss Westmoreland contacted Hite, Liaison Officer at the County's command post, visible from point a, Figure 3, below on the Pacoima Road. Hite told Westmoreland that King and his men were cold trailing the edge of the fire and that they would be able to construct line down the rocky chute in the chimney canyon. King was following his alternate choice in accordance with Line Boss Masterson's instructions.

Division Boss Westmoreland waited at point a (Figure 3) until the last of the El Cariso crew had cleared the rock face.

The Del Rosa Crew came down to point a. Westmoreland told them to wait at point a until he checked to see if this was the best way down. He would call them by radio and advise them to either come down the chute and leap-frog the El Cariso crew or to go down ridge A-45 - A-47 (Figure 2) and come in from below to meet the El Cariso crew.

Cue:
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Division Boss Westmoreland then proceeded down the rock face. When he was about half-way down the face, he could look down the chimney canyon most of the way. (Point b, Figure 3) Most of King's crew had crossed the rock slide at the head of the chute and had worked their way down a small bench that paralleled the chute (point c, Figure 3 is middle of bench).

Show Special Slide 5

The fire had backed down to the bench and gone out. It was not a clean burn.

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3:30 PM - King and some of his crew were at the "Diamond" (+2, Figure 4) with the rest of the crew strung out up the chute cold trailing along line A (Figure 4). Westmoreland was near point b (Figure 3). A helitanker was working in the area of the gully at the time.

Cue: Trace out fire edge on view presented to trainees on Transp. 4

The fire situation at approximately 3:30 PM was as follows: From the Diamond, the burned edge dipped into the adjacent gully; thence up to the end of the cat line; then west to a point high on the adjoining ridge. (Line a, Figure 4) King could see that the terrain was too steep to cold trail from the chimney canyon into the deep gully to the west and the bottom of this gully was obviously a difficult and dangerous place to hold the fire.

One of King's alternatives was to construct and hold an indirect line from the "Diamond" to the cat line across the adjacent deep gully to the west. This required building and holding line 50 to 100 feet away from the fire's edge, from the diamond along the east edge of the deep gully to a point opposite the cat line (Line b, Figure 4).

The distance between the cat line close to the edge of the fire on the oppostie draw and the edge near the diamond is approximately 500 feet. Of this 500 feet, 300 feet had a natural opening from 3 feet to 10 feet wide. The remaining distance at the lower end included some 200 feet of light brush cover near the edge of the steep gully. Fireline could be constructed through it rapidly. The El Cariso crew probably had the capacity to cut this 200 feet of line through to the gully edge in 10 to 15 minutes. The behavior of the fire at this time (3:30) was observed by Superintendent King from the "diamond", Division Boss Westmoreland from the ridge above it, Los Angeles County Fire Captain Hayes from the cat line, Coordinator Hite and others from the command post in Pacoima Canyon. The fire was in a static situation with hot spots on the west side and near the bottom of the deep gully 150 feet from the cat line. The winds were blowing from the southeast favoring closing the gap between the edges of the fire.

Loop Fire Exercise No. 3

1. List the alternative courses of action that were available to King as he sized up the situation at the "diamond".

2. List the fire behavior factors and any other key items for making any decision (but not necessarily actually known to King) at this point.

3. Explain the course of action you would take at this point and reasons why.

4. What additional actions would you have Division Boss Westmoreland take?

5. What should each man be doing?

Loop Fire

Angeles National Forest

November 1, 1966

Loop Fire Exercise No. 3 - Solution

1. Alternative courses:

   a. Build cold trail line along fire's edge into steep gully and then out to cat line on far side of gully.

   b. Build indirect line from the "Diamond" area along the east edge of the deep gully to a point opposite the cat line.

   c. Hold the crew at "Diamond" area, out of chimney canyon, send a scout down along the fire's edge into deep gully, and out, to scout line and make contact with L.A. County crew.

   d. Pull back uphill for new line choice.

   e. Abandon effort, pulling out to safe area.

2. Fire behavior factors key to decision (but not necessarily actually known to King):

   a. Topography - (1) chimney canyon, (2) steep sided deep gully with fire edge in bottom

   b. Fuels - light - dry - pre-heated by fires proximity

   c. Fire had spotted earlier

   d. County crews still working toward him from bottom

   e. Fire laying down - static situation

   f. Spot fires were not active

   g. Light fuels and some natural opening made line construction easy along east edge of gully

3. Hold crew at "Diamond". Send out scout with one foot in the burn to contact lower crew. Have pre-arranged signal and plan to use burned area away from (west) chimney as escape route. As possible, scout to determine plan of tie-in and best method of attack.

4. Westmoreland's actions:

   a. Provide communications for King.

b. Request helicopter so he could personally scout lower line and advise King (otherwise get info from helicopter working in area).

c. Automatically use his knowledge of Situations That Shout Watch Out and the 10 Standard Firefighting Orders as mental checklists for actions being taken by crews on his division.

5. Using the same mental checklists (item 4c) as Westmoreland.

LOOP FIRE

CHRONOLOGY OF EVENTS - CONCLUSION

3:30 PM - Two critical decisions were made: one by L.A. County Captain Hayes and one by King, Superintendent of the El Cariso crew. Captain Hayes decided that it would be unsafe and time consuming to attempt to cross the deep gully immediately ahead of the bulldozer. He sent the Los Angeles County Hand Crew out and around with orders to scout the opportunities of meeting King from the east side of the deep gully. King decided to cut straight down along line b (Figure 4) to meet the bulldozer firebreak. He was aware that the bulldozer could not cross the gully, but he was not aware that the County crew had pulled out and gone around to attempt to meet him on the east side of the deep gully.

King's decision was based on the fact that they were in light fuels, had a very favorable wind, no sign of fire activity on his side of the slope into the deep gully to the right and a natural break existed most of the way to the cat line which was clearly visible at the bottom of the canyon.

King's decision to go down toward the cat line with 2 men was made before it was obvious to him the fire crossed the gully.

Cue:
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3:35 PM - The fire crossed the deep gully, burned up the steep 50 foot slope on the east side and created a hot spot in the mouth of the chimney canyon.

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Slide 8

A combination of heavier fuels, eddy currents, and thermal effects caused a run up the east side of the draw and toward the west edge of the "Diamond".

King was approximately 60 feet from the fire as it spread across the mouth of the chimney canyon.

Sumac bushes and heavy litter in this area provided additional heat, which was all directed up the natural chimney. Heat from the fire in the lower part was sufficient to ignite the sparse fuel patches in the chimney. (Spread of the fire to the top of the chimney likely occurred in less than 1 minute.)

When the hot spot flared up, King, who was leading, had little or no time to do any more than yell at

his followers to "move out". He made one effort to go to his left around the fire and immediately realized he should change his course.

When King shouted for the crew to "move out", the remainder of the crew was strung out up the chimney above the diamond area. It is assumed that 11 of the crew moved toward the diamond area, or an area just above it. Ten stayed in or went into the chimney and did not survive. (Point 3, Figure 4) King came out below the fire, badly burned.

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Protective suits or tents would have lessened the severity of the injuries to those near the diamond but probably would not have saved the ten men in the chute.

Lessons to be Learned

When King started down from the point a (Figure 3) he had safety uppermost in his mind as he crossed the head of chimney canyon and went down the bench on the right side of the chimney. Rolling rocks had been brought to his attention as a hazard.

When King started down from the diamond area, he made the choice he did, believing that it was a cinch to cut line through the unburned brush toward the cat line. It is believed that he made a decision in which he thought everything was in his favor and that it was less risky than following the edge of the fire into the head of the adjoining deep gully. (This action would also have put him in a hazardous position in relation to the fire on the other side of the deep gully should a blow-up have occurred in that canyon below.

Many of us have and will likely again face a similar decision. We might easily have made the same decision King did. But HINDSIGHT is giving us a second chance. Some important lessons to be learned are:

1. Fire behavior was the largest safety hazard present on this segment of the Loop Fire. The fire behavior situation under Santa Ana or other Foehn wind conditions hangs in a delicate balance. Any slackening of the wind, surge of heat, an eddy current, the fire reaching different topography, or a combination of two or more of these factors can trigger a quick and violent change in the fire behavior. Such an event appears to have been the case in the Loop Fire accident.

2. Recognition of topographic effects on fire behavior. The shape of the country has a definite effect on how a fire will burn. Chimneys - chutes - narrow box canyons - saddles or any similar topographic features which become a natural draft or flue must be recognized as a hazard area even if devoid of fuel.

3. Improve intelligence by use of helicopter or on-the-ground scouting or both at all critical points in the fire area and particularly when 2 crews are working toward each other.

4. Provide intra division and inter crew communications, particularly when two crews are working toward each other.

5. Fight fire downhill only when you are positive all of these conditions are met:

a. You have a safe anchor point to start work.

b. Your crew can cold trail or burn out and build their fire line on the fire edge so that they always have "one foot in the burn". The burn must offer an area clean enough of fuels to be safe and must be out of any chimney.

c. Be positive that a crew is started up from the bottom to meet you on the same line, that they have turned the corner and have it held to prevent outflanking.

d. That you have communications with the crew you are working towards, with your Sector Boss and with some facet of scouting intelligence.

e. Be sure that every member of crew recognizes the effects of topography on fire behavior and recognizes chimneys, chutes, box canyons, saddles, etc. as definite hazards. Weather may change, but topography does not.

f. That all crew members have and wear protective clothing.

6. Build an "esprit de corps" in crews that says we are not only the best firefighters, but we are also the most knowledgeable in recognizing and taking action to meet every physical and natural challenge that a fire can present.

The best firefighter is one who knows all the hazards and how to avoid them while accomplishing the job. He follows, and sees that others follow, the TEN STANDARD FIREFIGHTING ORDERS.