

South Canyon Fire Investigation

of the 14 fatalities
that occurred on
July 6, 1994 near
Glenwood Springs,
Colorado



**Report of the
South Canyon Fire
Accident Investigation Team**

August 17, 1994

Report of the South Canyon Fire Accident Investigation Team

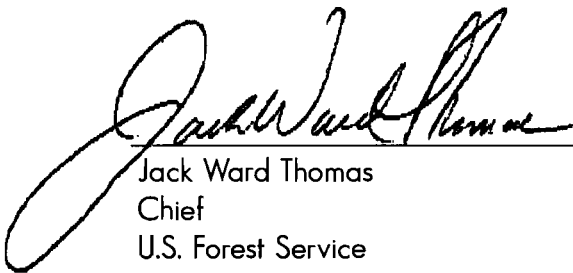
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8/17/94

Date

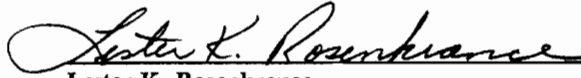


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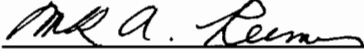
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Report of the South Canyon Fire
Accident Investigation Team
Glenwood Springs, Colorado
August 18, 1994



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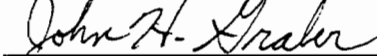
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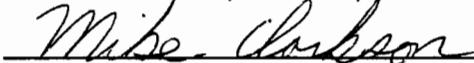
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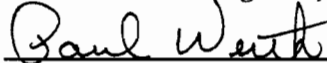
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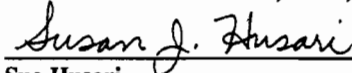
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In Memory Of

Kathi Beck

Tami Bickett

Scott Blecha

Levi Brinkley

Robert Browning

Doug Dunbar

Terri Hagen

Bonnie Holtby

Rob Johnson

Jon Kelso

Don Mackey

Roger Roth

James Thrash

Richard Tyler

May We All Be Energized And Inspired To Be Ever Aware
Of The Lessons Learned From Their Sacrifice

Report Of The South Canyon Fire Accident Investigation Team

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Preface

Firefighters and fire managers are engaged in a complex business that has inherent risks and requires skill, good judgment, and the ability to make difficult decisions. The South Canyon Fire tragedy resulted from a series of judgments, decisions, events, and actions with serious cumulative impacts. None of the people involved would have knowingly made decisions that led to the deaths of 14 firefighters.

The South Canyon Fire Interagency Investigation Team did not come to this assignment with any preconceived notions of why the accident occurred. Rather we came determined to be as factual, complete, and analytical as possible. We feel a strong responsibility to wildland firefighters everywhere, particularly those who lost their lives in this incident, to help reduce the risk of a recurrence of the deep, personal loss experienced in the South Canyon fire. Our report is presented to the Chief of the Forest Service and the Director of the Bureau of Land Management. We also request that each of you review the findings and analysis of causal factors. We further ask you to resolve to provide the leadership needed to give an extra margin of safety in all that we do and thus prevent a recurrence. We express our sincere thanks to each person who contributed to the investigation.

Executive Summary

The Incident

On July 2, 1994, during a year of drought and at a time of low humidity and record high temperatures, lightning ignited a fire 7 miles west of Glenwood Springs, Colorado. The fire was reported to the Bureau of Land Management on July 3 as being in South Canyon, but later reports placed it near the base of Storm King Mountain. The fire began on a ridge, which was paralleled by two canyons or deep drainages, called in this report the east and the west drainages. In its early stages the fire burned in the pinyon-juniper fuel type and was thought to have little potential for spread.

Dry lightning storms had started 40 new fires in BLM's Grand Junction District in the 2 days before the South Canyon fire started, requiring the District to set priorities for initial attack. Highest priority was given to fires threatening life, residences, structures, utilities, and to fires with the greatest potential for spread. All initial attack firefighting resources on the Grand Junction District were committed to the highest priority fires. In response to a request from the Grand Junction District, the Garfield County Sheriff's Office and White River National Forest monitored the South Canyon Fire.

Over the next 2 days the South Canyon Fire increased in size, the public expressed more concern about it, and some initial attack resources were assigned. On the afternoon of July 4 the District sent two engines. Arriving at 6:30 p.m. at the base of the ridge near Interstate 70, the crew sized up the fire but decided to wait until morning to hike to the fire and begin firefighting efforts.

The next morning, a seven person BLM/Forest Service crew hiked 2 1/2 hours to the fire, cleared a helicopter landing area (Helispot 1) and started building a fireline on its southwest side. During the day an air tanker dropped retardant on the fire. In the evening the crew left the fire to repair their chainsaws. Shortly thereafter, eight smokejumpers parachuted to the fire and received instructions from the Incident Commander to continue constructing the fireline. The fire had crossed the original fireline, so they began a second fireline from Helispot 1 downhill on the east side of the ridge. After midnight they abandoned this work due to the darkness and the hazards of rolling rocks.

On the morning of July 6 the BLM/Forest Service crew returned to the fire and worked with the smokejumpers to clear a second helicopter landing area (Helispot 2). Later that morning eight more smokejumpers parachuted to the fire and were assigned to build the fireline on the west flank. Later, ten Prineville Interagency Hotshot Crew members arrived, and nine joined

the smokejumpers in line construction. Upon arrival, the remaining members of the hotshot crew were sent to help reinforce the fireline on the ridgetop.

At 3:20 p.m. a dry cold front moved into the fire area. As winds and fire activity increased, the fire made several rapid runs with 100-foot flame lengths within the existing burn. At 4:00 p.m. the fire crossed the bottom of the west drainage and spread up the drainage on the west side. It soon spotted back across the drainage to the east side beneath the firefighters and moved onto steep slopes and into dense, highly flammable Gambel oak. Within seconds a wall of flame raced up the hill toward the firefighters on the west flank fireline. Failing to outrun the flames, 12 firefighters perished. Two helitack crew members on the top of the ridge also died when they tried to outrun the fire to the northwest. The remaining 35 firefighters survived by escaping out the east drainage or seeking a safety area and deploying their fire shelters.

The Investigation

Within 3 hours of the blowup, an interagency team was forming to investigate the entrapment on the South Canyon fire. The team first met on the evening of July 7. Team members were given their assignments, and the team presented a charter to the Chief of the USDA Forest Service and the Director of the Bureau of Land Management. Les Rosenkrance, BLM's Arizona State Director, was designated team leader.

In the next few days the team investigated the fire and fatality sites and began a series of 70 interviews with witnesses. In addition, the team met once or twice a day to discuss progress, clarify assignments, plan their report, and review their findings. On July 22, with the interviews and much of the investigation report completed, the team adjourned. The following week some team members met in Phoenix, Arizona to complete work on the incident overview. On August 9-11, the team reconvened to review a draft of the completed report in preparation for its publication.

Causal Factors

Direct Causes

The Investigation Team determined that the direct causes of the entrapment in the South Canyon fire are as follows.

Fire Behavior

Fuels

- Fuels were extremely dry and susceptible to rapid and explosive spread.
- The potential for extreme fire behavior and reburn in Gambel oak was not recognized on the South Canyon fire.

Weather

- A cold front, with winds of up to 45 mph, passed through the fire area on the afternoon of July 6.

Topography

- The steep topography, with slopes from 50 to 100 percent, magnified the fire behavior effects of fuel and weather.

Predicted Behavior

- The fire behavior on July 6 could have been predicted on the basis of fuels, weather, and topography, but fire behavior information was not requested or provided. Therefore critical information was not available for developing strategy and tactics.

Observed Behavior

- A major blowup did occur on July 6 beginning at 4:00 p.m. Maximum rates of spread of 18 mph and flames as high as 200 to 300 feet made escape by firefighters extremely difficult.

Incident Management

Strategy and Tactics

- Escape routes and safety zones were inadequate for the burning conditions that prevailed. The building of the west flank downhill fireline was hazardous. Most of the guidelines for reducing the hazards of downhill line construction in the Fireline Handbook (PMS 410-01) (see box on page 36) were not followed.
- Strategy and tactics were not adjusted to compensate for observed and potential extreme fire behavior. Tactics were also not adjusted when Type I crews and air support did not arrive on time on July 5 and 6.

Safety Briefing and Major Concerns

- Given the potential fire behavior, the escape route along the west flank fireline was too long and too steep.
- Eight of the 10 Standard Firefighting Orders were compromised.
- Twelve of the 18 Watch Out Situations were not recognized, or proper action was not taken.
- The Prineville Interagency Hotshot Crew (an out-of-state crew) was not briefed on local conditions, fuels, or fire weather forecasts before being sent to the South Canyon fire.

Involved Personnel Profile

- The "can do" attitude of supervisors and firefighters led to a compromising of Standard Firefighting Orders and a lack of recognition of the 18 Watch Out Situations.
- Despite the fact that they recognized that the situation was dangerous, firefighters who had concerns about building the west flank fireline

questioned the strategy and tactics but chose to continue with line construction.

Equipment

- Personal protective equipment performed within design limitations, but wind turbulence and the intensity and rapid advance of the fire exceeded these limitations or prevented effective deployment of fire shelters.
- Packs with fuses taken into a fire shelter compromised the occupant's safety.
- Carrying tools and packs significantly slowed escape efforts.

Contributory Causes

The following factors contributed to the entrapment on the South Canyon fire.

Incident Management and Control Mechanisms

- The initial suppression action was delayed for 2 days because of higher priority fires on the Grand Junction District.
- Air support was inadequate for implementing strategies and tactics on July 6.

Support Structure

- The above-normal fire activity overtaxed a relatively small firefighting organization at the Grand Junction District and Western Slope Fire Coordination Center.
- Detailed fire weather and fire behavior information was not given to firefighters on the South Canyon fire.
- Dispatching procedures and communications with the Incident Commander did not give a clear understanding of what resources (crews and air support) would be provided to the fire in response to requests and orders.
- Unclear operating procedures between the Western Slope Fire Coordination Center and the Grand Junction District's fire organizations resulted in confusion about priority setting, operating procedures, and availability of firefighting resources, including initial attack resources (i.e. helitack firefighters, smokejumpers, and retardant aircraft). This lack of definition limited the effectiveness in the timing and priority of the suppression of the South Canyon fire.
- The lack of Grand Junction District and Colorado State Office management oversight, technical guidance, and direction resulted in uncertainty concerning the roles and responsibilities of the Western Slope Fire Coordination Center and the Grand Junction District.

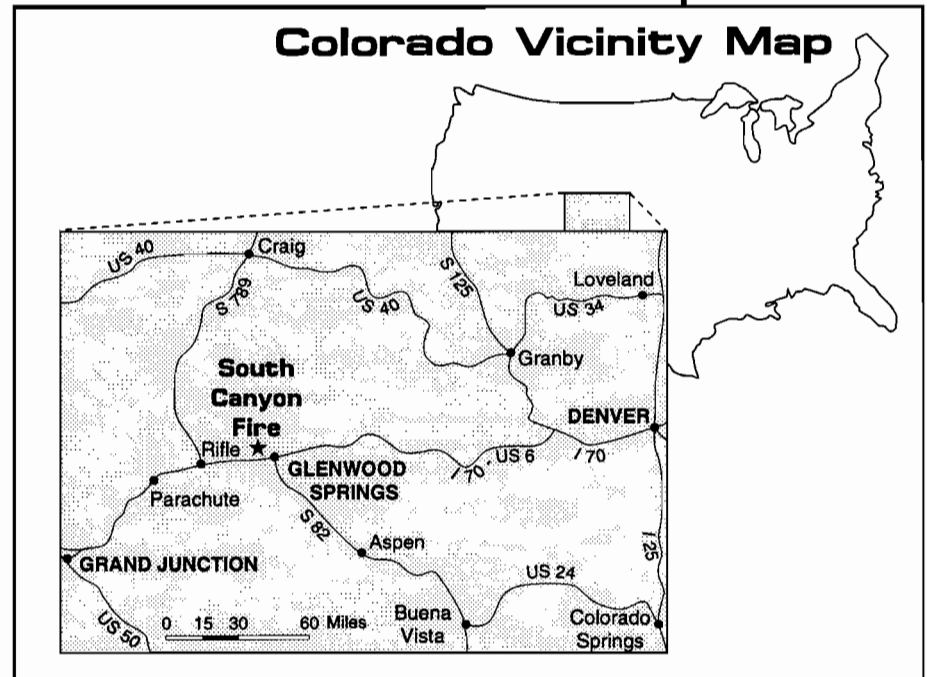
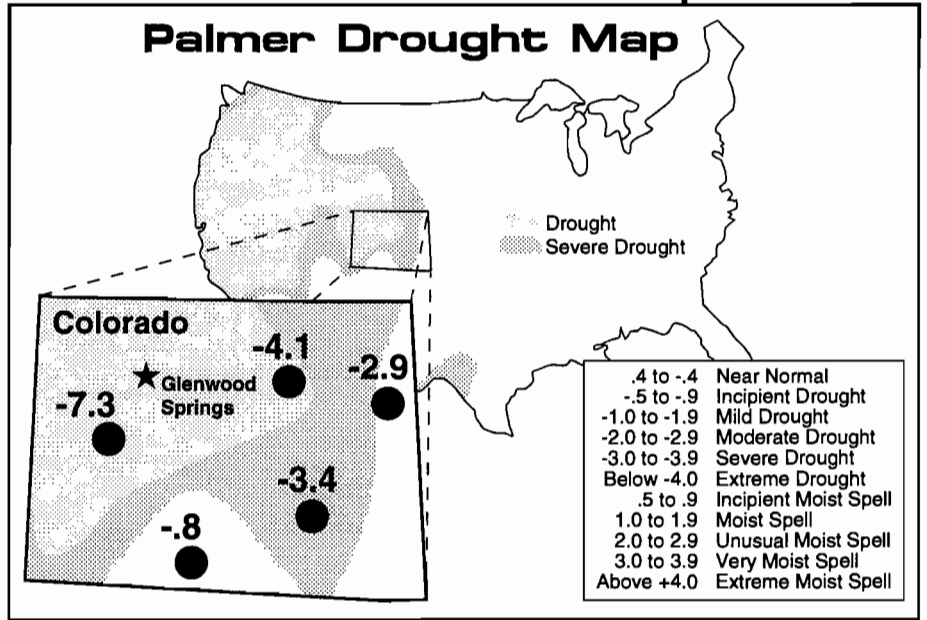
Incident Overview

Background

Colorado experienced record high temperatures during June of 1994. A weather pattern of dry thunderstorms caused a rash of wildfires. Red flag watches and warnings were issued for western Colorado based on forecasts for dry thunderstorms with strong and gusty winds. Western Colorado was in extreme drought, as shown on the July 9 Palmer Drought Index map. The Glenwood Springs area had received only 58 percent of normal precipitation since October 1993.

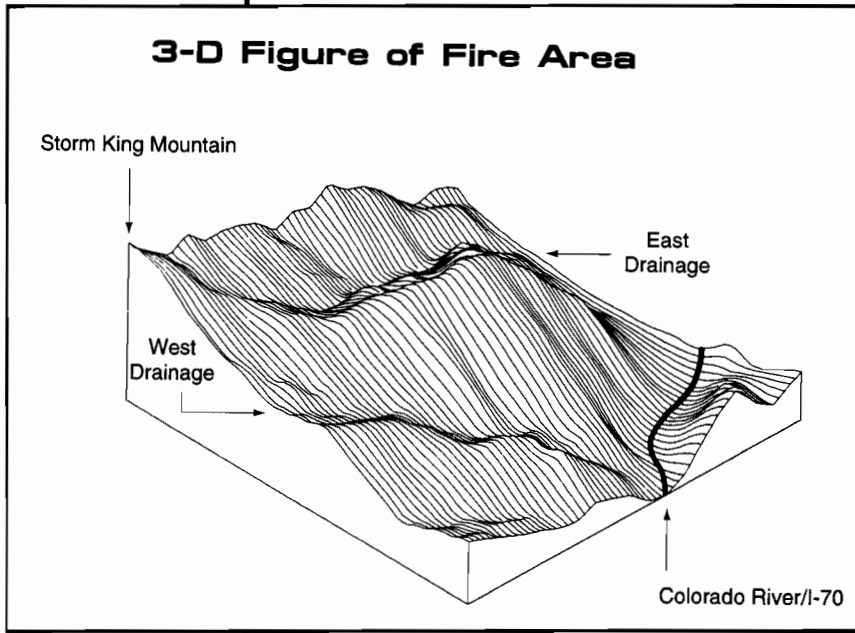
The Bureau of Land Management's Grand Junction District was experiencing a severe fire season. Fire danger indices for July were at the highest levels recorded in 21 years. As of early July the number of fires was twice the annual average. Type I and II incident management teams had responded to five times the number of fires that they would respond to in a normal year. The district's Management Team had issued a directive that all fires be initial attacked and suppressed as soon as possible. Statewide fire prevention restrictions were issued for Colorado on June 29, 1994.

The South Canyon fire occurred about 7 miles west of Glenwood Springs in west-central Colorado, burning about 2,000 acres in the 3-day period of July 3-6. The fire site, which adjoins Interstate 70 and the Colorado River, straddles a ridge extending off of Storm King Mountain. The ridge is paralleled to



South Canyon Fire

3-D Figure of Fire Area

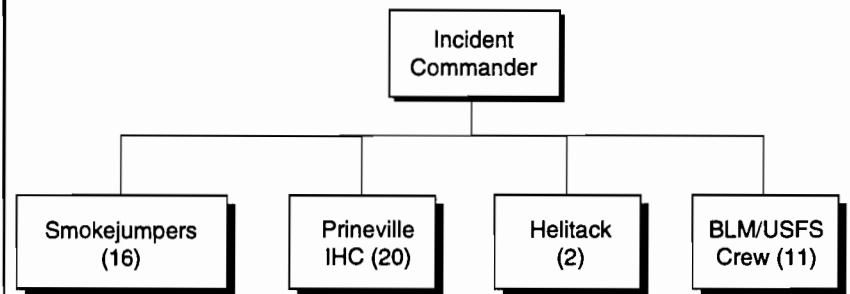


the east and west by two major canyons or drainages that lead to the Colorado River. This report calls these canyons the east and west drainages. The fire was first reported to be in South Canyon, but later reports placed it near the base of Storm King Mountain.

At the time of the blowup on July 6, the South Canyon fire was considered an extended attack fire—a fire of generally less than 100 acres that has not quickly been brought under control by the initial suppression actions and requires more firefighting resources. The South Canyon fire had not yet reached a level of organizational complexity which required a designated “overhead team” of fire supervisors to assume control. As is typical in extended attack situations, firefighting groups arrived on the fire at intervals from dispersed locations and blended into the existing organization. Also typical was the assignment of the highly trained hotshot crew and smokejumpers to the most difficult portions of the fire.

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Organization of South Canyon Extended Attack Team



The following daily account describes the events that preceded the accident.

July 2

The South Canyon fire was ignited by lightning on the afternoon of July 2, 1994.

July 3

The Grand Junction District was in very high to extreme fire danger, with 90 percent of its firefighting resources committed to fires. Lightning storms during the previous 2 days had resulted in more than 40 new fires, and the district had developed a priority list for initial attack. Highest priority was given to fires threatening residences, structures, and utilities, and to fires with the highest potential for spread. A red flag warning was issued for dry lightning, and strong winds hampered the effective use of aircraft in fighting wildland fires.

South Canyon Fire

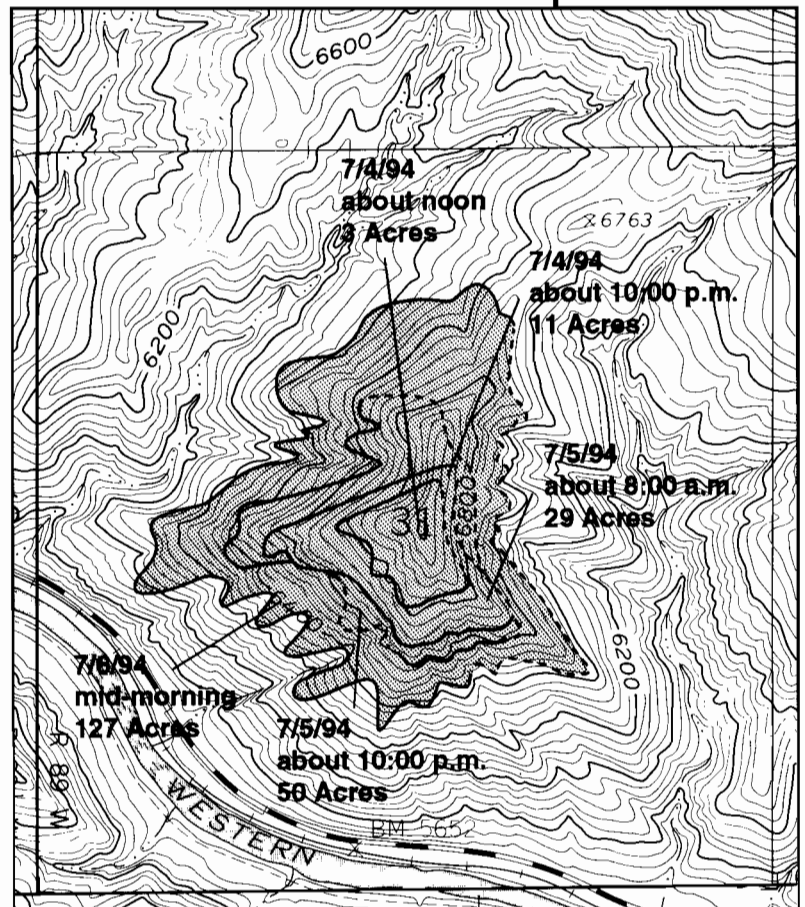
At 11 a.m. the Garfield County Sheriff reported the South Canyon fire to the Grand Junction District Dispatch Center. This fire was located on a hilltop above Interstate 70 about 7 miles west of Glenwood Springs. The District Fire Control Officer was notified of the fire and drove to the scene. Dispatch called the Western Slope Fire Coordination Center in Grand Junction and requested one load (eight) of smokejumpers, an air tanker, and a lead plane to respond to this and other fires reported in the area.

BLM Engine Crew E611 arrived at the scene and met with the Garfield County Sheriff. The Engine Foreman completed the initial sizeup and confirmed that the fire was on BLM-administered land. With only the flaming canopies of two trees visible, this fire seemed to have a low spread potential. The Engine Foreman recommended that the fire be observed until firefighting resources could be obtained. There were higher priority fires, slopes were steep, the fire was inaccessible, and rates of spread were slow. The Grand Junction District Fire Control Officer arrived at the scene and agreed with the Engine Foreman's assessment and recommendation.

Three aircraft—Lead 64, Jumper 49, and Air Tanker 14—were diverted to other priority fires in the area. The Fire Control Officer arrived back in Grand Junction to assess fire activity and plan for the next day. He called the Western Slope Fire Coordination Center and requested more firefighting resources for the South Canyon fire. He also called for Grand Junction District firefighting resources to be released from the Copper Spur fire in the Craig District for reassignment to the South Canyon fire.

July 4

Five new fires started on July 4, two of which exceeded 100 acres. In addition, 31 existing fires remained uncontrolled. Local initial attack forces were committed to other fires. Radio communication was inadequate for the fire load and was recognized as a potential problem for safe and effective aircraft use. Fire danger throughout the district was very high to extreme. More lightning was forecast for that evening. Red flag warnings were issued.



South Canyon Fire

The South Canyon fire was given a higher priority for receiving firefighting resources in response to concerns of Glenwood Springs residents. At 2:50 p.m. the White River National Forest, Sopris Ranger District informed Grand Junction District Dispatch that it had received a telephone call from



Photo 1. The South Canyon fire at noon on July 4.

a resident concerned about the fire and that in response it was sending an engine crew to the fire site. At 3:40 p.m. the Sopris Ranger District reported to Dispatch that the fire posed no danger to structures. Dispatch responded that a BLM engine crew was enroute to the fire site.

At 6:30 p.m. the Incident Commander, and BLM and Forest Service firefighters met at the bottom of the hill. They sized up the fire and decided that because of darkness and steep terrain they would hike up to attack the fire early on July 5. Later that evening a Forest Service aerial observer

reported that "The fire is in steep and inaccessible terrain. It is burning to the northeast on the ridge. The area is too steep for crews and has few if any escape routes. The fire is actively burning in all directions. Helicopters with buckets could be very effective." The Grand Junction District Fire Management Officer and the Manager of the Western Slope Fire Coordination Center discussed the need for more resources for the fire.

From noon to 10 p.m on July 4 the fire had grown from 3 to 11 acres. The photo and fire map show the fire at noon.

July 5

The morning briefing at the Western Slope Fire Coordination Center called for red flag warnings and very high to extreme fire danger. A BLM crew of seven walked into the fire from the east drainage. The crew cut helispot 1—a helicopter landing area—on the ridge above the fire and began direct fireline construction downhill along the fire edge below the helispot. The Incident Commander ordered another district engine crew, a helicopter, and a 20-person crew. A load of eight smokejumpers was substituted for the 20-person crew and was sent to the fire.

An air tanker drop was requested to support fireline construction. The first load of retardant was dropped along the fireline starting at the helispot. The Incident Commander and the air tanker pilot agreed that more retardant drops would be ineffective because of steep terrain and gusty winds.

The next air tanker drop was used to the south on the rocky slope overlooking the river and Interstate 70. The possibility of causing rocks to roll on the interstate restricted the further use of air tankers.

At 5:30 p.m. the Incident Commander and BLM crew left the fire to refurbish their equipment. Eight smokejumpers parachuted into the top of the fire at 5:45 p.m. and radioed the Incident Commander. The Incident Commander directed them to work on the fireline from the helispot downhill toward the west drainage.

The Jumper in Charge informed the Incident Commander that the fire had crossed their fireline and was burning actively. The jumpers then began building a fireline down the east side of the ridge. After sizing up the fire, the Jumper in Charge called Grand Junction District Dispatch and ordered two Type I crews.

On July 5 the fire grew from 29 acres at 8:00 a.m. to 50 acres at 10:00 p.m.

July 6

Thirty-six fires were burning in the Grand Junction District. The fire weather forecast for July 6 issued at 7:30 p.m. on July 5 for the Grand Junction area predicted increasing high clouds in the morning with winds of 10-20 mph by 11 a.m. and winds increasing to 15-30 mph by 1 p.m. By 3:00 p.m. surface winds would shift to the northwest at 15-25 mph and would gust to 30-35 mph with the passage of a cold front. A red flag warning had been issued for winds associated with the front.

Early in the morning (12:30 a.m.) the jumpers abandoned their line construction on the east side of the fire because of darkness and the hazards of rolling rocks. The fire continued

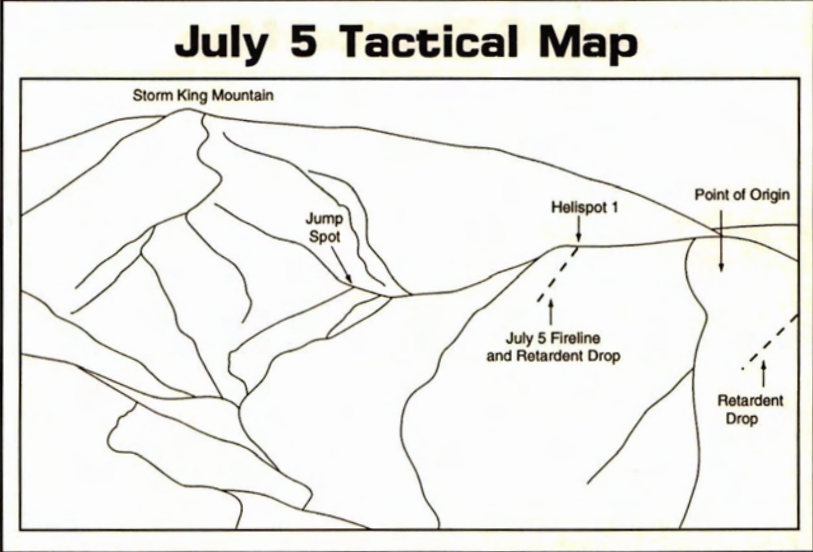
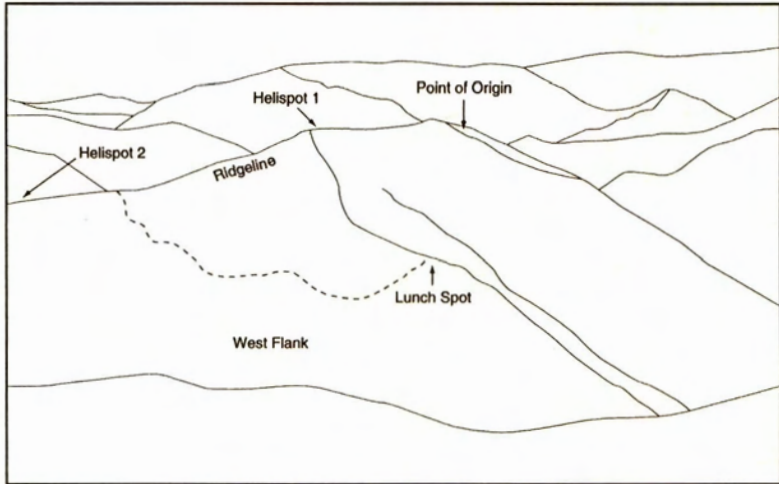


Photo 2. July 5 Tactical Map photo.

South Canyon Fire

to flare up throughout the night, and the jumpers become concerned about the fire burning over the jump site where they had left their parachutes and equipment.

July 6 Tactical Map



The Grand Junction Dispatcher summarized the fire weather forecast for the Incident Commander over the telephone. The forecast called for windy conditions with the passage of a cold front. At 4:30 a.m. the 11 BLM/Forest Service firefighters began their 3 1/2-hour hike back to the fire up the east drainage. Arriving at the fire sites they cleared Helispot 2.

At 5:30 a.m. the Jumper in Charge ordered a helicopter for gear removal and requested a fixed-wing aircraft with an aerial

observer. An hour later, Grand Junction Dispatch assigned the Prineville Interagency Hotshot Crew to the fire. The Jumper in Charge then requested that the hotshot crew be ferried into the fire by helicopter and that he have use of the helicopter for reconnaissance. Dispatch and the Jumper in Charge agreed that the helicopter would be used for reconnaissance instead of the fixed-wing aircraft and aerial observer. At 8:00 a.m. the Prineville Hotshot Crew departed from Grand Junction on a bus. Because of difficulties in acquiring tools and equipment, the hotshots did not arrive at the helibase until 11:00 a.m.

At 8:45 a.m. the Incident Commander and the Jumper in Charge discussed strategy and tactics for the day. The plan was to improve the fireline on the ridge between Helispots 1 and 2 and to have the eight jumpers and the Prineville Hotshot Crew start build-

ing a fireline along the fire's edge on the west flank.



Photo 3. July 6 Tactical Map photo.

At 9 a.m. the Incident Commander and several of the jumpers programmed their fire radios to the NOAA weather channel and received the following general Grand Junction area weather forecast: Windy and cooler, highs in the mid 80s, west to northwest winds 15 to 25 mph with some stronger gusts, sunny in the morning, partly cloudy by afternoon. In the evening, cooler with possible record low temperatures, lows 50 to 55, partially cloudy with isolated showers, decreasing northwest winds." The Grand Junction District Dispatch Center informed the Incident Commander that he could keep the smokejumpers on the fire and that eight more jumpers were headed his way.

At 9:30 a.m. helicopter 93R arrived on the fire but was limited to 4 hours flying time because of anticipated new fires. The Incident Commander and Jumper in Charge took a reconnaissance flight of the fire and directed the jumpers to start building a fireline downhill on the west flank. The Jumper in Charge and a jumper on the ground discussed the lack of safety areas on the fire. Followup discussion on the ground resulted in continuing the original plan.

At 10:30 a.m. the jumper aircraft arrived over the fire, and eight more smokejumpers parachuted down to the fire site. This group was used to reinforce line building on the west flank. At 12:30 p.m., the Prineville Hotshot Crew Superintendent and nine crew members arrived at Helispot 2 by helicopter. The Incident Commander, Jumper in Charge, and Hotshot Crew Superintendent discussed strategy and agreed to send nine hotshots down the west flank to reinforce the jumpers. The arrival of the second half of the hotshot crew was delayed so that the helicopter could be used to ferry equipment and for water drops on flareups.

At 1:00 p.m. a flareup on the west flank of the fire forced a group of jumpers to momentarily retreat up the fireline toward the top of the ridge. Several of the jumpers discussed their concerns about the safety of building the fireline. After a water drop from the helicopter cooled the flareup, the jumpers proceeded down the hill to continue building the fireline.

Between 12 noon and 1:00 p.m. winds in Grand Junction increased from 10 mph to 22 mph with gusts to 30 mph.

At 2:30 p.m. after a lunch break, three jumpers were instructed to work back up the west flank looking for hot spots and improving the line. The Line Scout continued south and down the hill past the end of the fireline to size up the next section of fireline.

At 3 p.m. the 10 other Prineville Hotshot Crew members arrived at Helispot 2 by helicopter and were instructed to help widen the fireline and put out spot fires along the ridge.

South Canyon Fire

At 3:20 p.m. a dry cold front with strong winds moved into the fire area. Fire activity immediately began to pick up.



Photo 4. Fire behavior at 3:45 p.m.

At 3:45 p.m. the fire made several rapid runs with 100-foot flame lengths within the burned area just above the Line Scout. A short time later, helicopter water drops were called for on the west drainage and the ridgeline. At this point, fire activity was so intense that water drops were not effective. The people improving the handline noticed the activity and started walking out the fireline.

At 4:00 p.m. the fire blew up. It crossed the west drainage at the base of the gully below the Line Scout. Within seconds a wall of flame raced up to the opposite ridge. A jumper who viewed the blowup called for the Line Scout to get out of the area. The Incident Commander directed the Jumper in Charge to bring

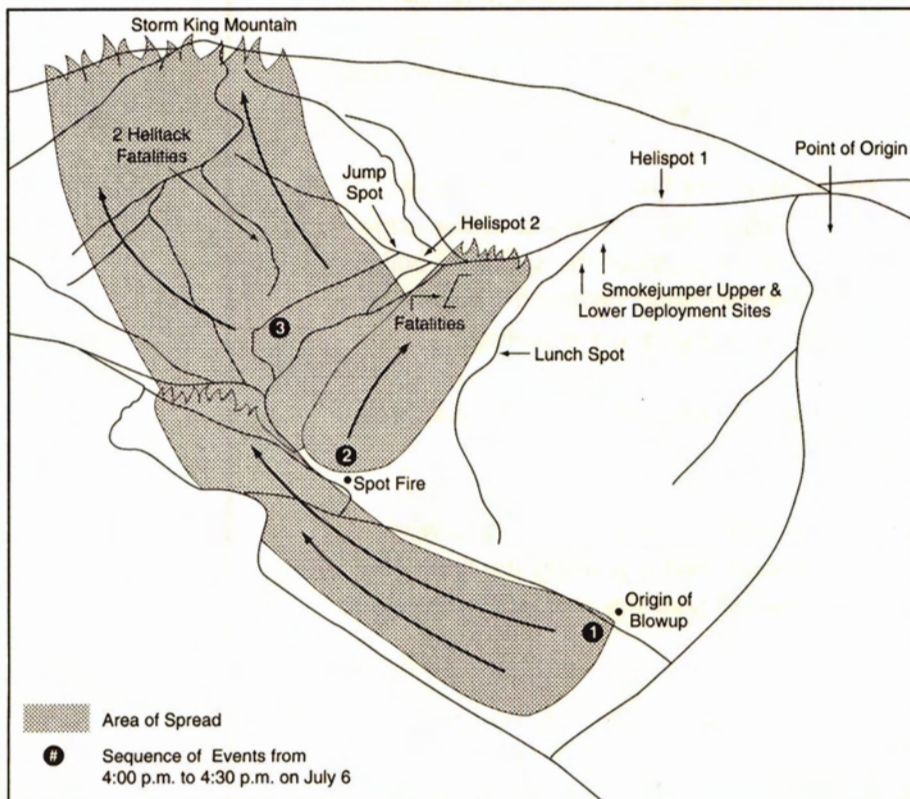
the firefighters up from the bottom of the fireline. The jumper with the view of the blowup called the Jumper in Charge to tell him that the fire had crossed the main drainage and was "rolling."

The fire rushed up the west side of the drainage pushed by 30-mph winds. In 10 to 12 minutes the fire had progressed up the canyon to a point across from the firefighters hiking up the fireline.

At 4:11 p.m., the Incident Commander called Dispatch to report that he was los-

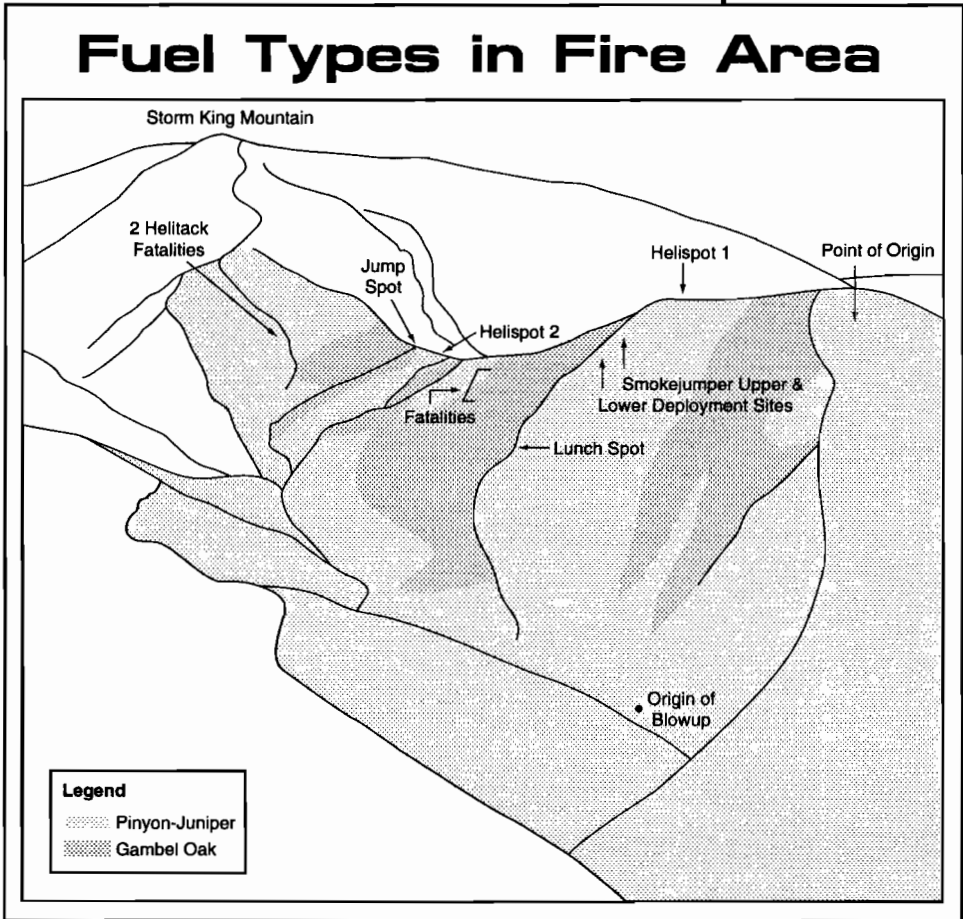
ing the fire on the side where the homes were and that he needed air tankers. At 4:20 p.m. an air tanker was dispatched.

Fire Blowup See photo 2 on pg. 9



Between 4:14 and 4:18 p.m. the fire was observed to spot back to the east side of the drainage below the crew that was walking out the fireline to the ridge. As the fire raced up the slope, it was influenced by stronger winds of 40 mph. The spot fire reached the ridgeline in 2 minutes. During the run the fire's rate of speed accelerated from 3 to 11 mph.

At the time of the accident 16 smokejumpers, 20 hotshots, a six-person helitack crew (two on the fire and four at the helibase), and 12 BLM/Forest Service firefighters (11 on the fire and 1 at the helibase) were assigned to the fire. The events occurring between 4 p.m. and 4:24 p.m. have been described separately to help clarify specific actions.



I. Jumpers That Deployed Fire Shelters In The Safe Area

Shortly after the fire crossed the west drainage, at about 4:10 p.m., jumpers Keith Woods, Quentin Rhoades, Sonny Soto, Eric Shelton, Bill Thomas, Tony Petrelli, Michael Cooper, and Mike Feliciano met the Jumper in Charge Don Mackey at the lunch spot. Mackey told the jumpers to move up the ridge to a previously burned out safe area below Helispot 1.

Mackey then left to check on Line Scout Dale Longanecker and the other firefighters on the west flank. The eight jumpers headed quickly up the steep ridge attempting to reach the safety zone and distance themselves from the blowup. Part way up the hill the jumpers dropped their chainsaws and gasoline. For this group, dropping their equipment was acknowledging their serious situation. At this time the wind was blowing so hard that the jumpers had to use the chinstraps on their hardhats. During the ascent, the smokejumpers were enveloped in smoke and flying embers and could hear the roar of the fire. Once in the safety zone, they had difficulty deploying their fire shelters due to the 40 mph winds. Six deployed their shelters in

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one cluster, and the other two deployed slightly down the hill. By 4:24 p.m. all the firefighters in this group were in their shelters. They called Mackey but got no response.



Photo 5. Blow up between 4:30 and 5:00 p.m.

Petrelli described the fire as he experienced it from his fire shelter: "When in the shelters, the fire made three different runs on our right side, approximately 200 yards away. Inside the shelter it heated up to 110 degrees. During the hottest run there were glowing fire brands blowing into the shelter. Between fire runs we would peek out (of) the shelter. There was still heavy smoke coming from below us. The wind was still blowing ash and dust."

After 1 1/2 hours, they came out of their shelters and met Longanecker, who had safely endured the blowup near the lunch spot. He had not deployed his shelter.



Photo 6. Fireline and deployment sites.

2. The Group On The Ridgeline

At the time of the blowup Prineville Interagency Hotshot Crew Superintendent Tom Shepard and 10 crew members—Tom Rambo, Alex Robertson, Kip Gray, Mike Simmons, Bill Baker, Brian Lee, Tony Johnson, Louie Navarro, Kim Valentine, and Bryan Scholz and the BLM crew Michelle Ryerson, Jim Byers, Mike Hayes, Loren Paulson, Neal Shunk, Brian Rush, Todd Abbott, Eric Christianson, Derek Brixey, and jumpers Sarah Doehring and Sabinio Archuleta were on the ridgeline. At 4:04 p.m. the Incident Commander Butch Blanco gave the word for all firefighters on the ridge to proceed to the safety zone at Helispot 1.

Before anyone could reach the safety zone, it became apparent that their path was cut off by an approaching wall of flame. Several crewleaders

ordered everyone to reverse directions toward Helispot 2 (the second designated helicopter landing area). From that point Blanco and other crewleaders directed everyone over the ridge and down the east drainage to the interstate. These firefighters safely escaped with only minor injuries.

According to Navarro, "As I looked up, I saw huge black clouds and red glare. The people in front said they couldn't make it to the black at H-1. As we turned back, I stayed in the rear to make sure everyone was together and going in the right direction. As I was coming out, I was flanked on both sides by fire. Some firefighters were tired and wanted to deploy. As we moved down the ridge, I could feel the fire on the west side gasp for air and then just surge like a tidal wave. When I reached the line that dropped off the hill, the fire was only on my left or west. It was hot and slamming against the ridge."



Photo 7. East drainage escape route.

Crews that dropped off the ridge fled down the east drainage. The wind blew the fire down this drainage, whose mouth was consumed in flames 30 to 40 minutes after the last firefighter escaped.

3. The Group On The West Flank

At the time of the blowup, Prineville Interagency Hotshot Crew members Jon Kelso, Kathi Beck, Scott Blecha, Levi Brinkley, Bonnie Holtby, Rob Johnson, Tami Bickett, Doug Dunbar, and Terri Hagen, and jumpers James Thrash, Roger Roth, and Eric Hipke were improving and holding the west flank fireline. When the fire crossed the west drainage, Blanco and Mackey ordered the firefighters up the hill. Mackey proceeded from the lunch spot up the fireline to follow them. Kevin Erickson and Brad Haugh waited at the upper part of the fireline to encourage the crew coming up the hill. As the crew came into sight, Erickson saw a spot fire ignite below the crew near the bottom of the drainage. He immediately called a warning to Mackey on the radio.

At this point, all the firefighters were walking in a line carrying all their equipment. Haugh later reported, "It appeared to me that the crew was unaware of what was behind them, as they were walking at what I consid-

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ered a slow pace, tools still in hand, packs in place, and the sawyer still was shouldering his saw....There was a slight ridge behind the crew which obscured our view of the bottom of the fire. The fire roared behind the



Photo 8. Spot fire approaching ridgeline.

ridge, and that was the first indication of how bad it had gotten....The fire storm literally exploded behind the ridge with approximately 100-foot flame height. At this point I decided I had to run. I can't recall if anyone was ahead of me or not, nor can I recall what the crew's reaction was to the blowup. As I neared the crest of the ridge, the heat was intense. I topped out and headed down the other side about 150 feet. When I turned around, a wall of flame 150 feet tall and 1/4 of a mile wide was on the ridgetop and starting to roll down the east side of the ridge."

As the spot fire rapidly spread, Erickson and Haugh yelled for all to drop their equipment and run. Thrash, at the head of line, gave the word to



Photo 9. Fireline and fatality site.

deploy shelters. As the fire raced toward the crew, Erickson and Haugh, who were shouting encouragement, turned and ran for the ridgetop. They were quickly followed by Eric Hipke, who chose not to deploy his shelter but to make a run for it. As the three running firefighters dove over the ridgetop, 200-foot flames blasted over the ridge, and all three received burns. The last jumper over the ridge, Hipke, was knocked down by the force of heat and flames. Erickson and Haugh tended to Hipke's burns, and then all three followed the east drainage down to Interstate 70 and safety. Erickson guessed that the spot fire spread to the top of the ridge in a matter of 30 seconds.

The fire overtook Mackey, Roth, Thrash, Kelso, Beck, Blecha, Brinkley, Holtby, Johnson, Bickett, Dunbar, and Hagen. They died just short of the ridgetop.

4. Helitack Crew

Helitack crew members Richard Tyler and Robert Browning had been directing helicopter operations from Helispot 2. As the fire threatened to crest the ridge, firefighters dropping into the east drainage shouted for Tyler and Browning to follow them into that drainage. But Tyler and Browning apparently did not believe the drainage was a safe escape route and chose to run along the top of the ridge above the jump site. The fire funnelled through the saddle at the jump site and cut off a route to the east. The slope to the northwest looked relatively flat with rock outcrops. The route appeared to be the best. Flanked by fire, Tyler and Browning headed in that direction. In 150-200 yards a steep rocky chute 50 feet deep blocked their escape. They tried to cross the chute but died when they were overcome by the fire in the chute.

As the fire blew up, helicopter pilot Dick Good dropped his water bucket at the helibase and returned to the fire to find the entire mountain in flame and smoke. He could not reach anyone.

The Grand Junction Fire Control Officer Winslow Robertson assumed responsibility for the South Canyon fire at 5 p.m. on July 6. He established an Incident Management Group of interagency fire people. This group managed the fire from 7 p.m. until midnight on July 6. At this time, a Type I Incident Management Team assumed control of the fire.

Investigation

As soon as it was known that firefighters had died on the South Canyon fire, an interagency accident investigation team was designated by the Director of the Bureau of Land Management and the Chief of the Forest Service. The team consisted of the following 10 members.

Les Rosenkrance, Leader, BLM
Mark Reimers, USFS
Roy A. Johnson, BLM
Jim Webb, USFS
John H. Graber, USFS (Union Rep.-NFFE)
Mike Clarkson, BLM
Paul Werth, National Weather Service
Sue Husari, USFS
Dick Mangan, USFS
Ted Putnam, USFS

The team was given full authority to use whatever other technical or support people that were necessary to complete the accident investigation and was directed to do the following:

1. Identify factual data associated with the circumstances relating to the incident.
2. Accurately and objectively record the findings of its investigation.
3. Analyze the findings to determine factors involved and their relationships.
4. As appropriate, recommend actions that should be immediately implemented to prevent similar future occurrences.
5. Develop and submit a factual report and an investigative report to the Director of the Bureau of Land Management and the Chief, U.S. Forest Service within 45 days of the accident.

The team first met on the evening of July 7 in Grand Junction, Colorado. Over the next 2 weeks, it investigated the fire and fatality sites and conducted a series of 70 interviews with witnesses. In addition, the team met regularly to discuss progress, clarify assignments, plan their report, and review their findings. On July 22, with the interviews completed and much of the investigation report drafted, the team adjourned with individual members continuing specific assignments. On August 9-11, the team reconvened to review a draft of the completed report in preparation for the report's publication and presentation to the Director of BLM and Chief of the Forest Service.

The team made every effort to complete its work within the specified 45 days to facilitate timely consideration of its findings by the Interagency Management Review Team. Some analysis of the entrapment response is

continuing. Should this or any other analysis result in any new findings, they will be given to the Management Review Team as a supplement to this report.

Findings

This section presents the South Canyon Fire Investigation Team's findings, which are supported by interviews, witness statements, physical evidence, Forest Service standard forms, and other information held in the investigation file in the Bureau of Land Management's Colorado State Office. The Investigation Team used the "Fire Entrapment Investigation and Review Guidelines," developed by the National Wildfire Coordinating Group (Appendix 12). Following these guidelines, the team assessed (and marked in parentheses) how categories of findings contributed to the accident: "significantly contributed," "influenced," or "did not contribute."

Fire Behavior

Fuels (significantly contributed)

- The primary fuel type burning on July 3, 4, and 5 was pinyon-juniper.
- Gambel oak was the predominant fuel consumed on July 6 in the rapid run culminating in the fatalities. Gambel oak was recognized as a highly flammable and hazardous fuel type in the accident report on the Battlement Creek fire (in the Grand Junction District within 30 miles of the South Canyon fire), which killed three firefighters in 1976.
- Live fuel moisture in the green Gambel oak was 125 percent.
- Live fuel moisture in the underburned Gambel oak was so low (60 percent) that it reacted much like dead fuel.
- Both annual and perennial grasses were completely cured.
- Gambel oak ranged from 6 to 12 feet high.
- The evacuation route and the successful deployments of fire shelters were in the pinyon-juniper fuel type. Unsuccessful deployments along the fireline were in the Gambel oak fuel type.
- The gullies and ravines in the fire area did not block the spread of fire.

Weather (significantly contributed)

- No weather observations were taken onsite.
- No spot weather forecasts were requested for the fire.
- Some firefighters knew a cold front was expected on July 6.
- The Investigation Team could find no one on the fire who knew of the red flag warning.
- The Incident Commander and some of the smokejumpers listened to NOAA Weather Radio, which continuously broadcasts weather information directed toward the public but does not broadcast fire weather forecasts or red flag warnings.
- The hotshot crew was informally told of an expected cold front with rain but was not given a weather briefing when arriving in Grand Junction.
- A fire weather meteorologist was assigned to the Western Slope Fire Coordination Center to give forecasts and briefings for specific wildfires. He was not, however, used on this fire.

- The Grand Junction District Dispatch Center briefed the Incident Commander on fire weather at 4:30 a.m. on July 6 but did not mention the red flag warning.
- A cold front moved into the fire area at around 3:20 p.m. on July 6. Winds dramatically increased and became very strong. At the time of the blowup, winds on the fire were estimated to be as high as 45 mph on the upper west slope near the fatalities.
- Fire weather forecasts were not being effectively communicated to firefighters on wildfires.
- A system was not in place to alert people on wildfires of significant weather changes. On July 6 between 12 noon and 1:00 p.m. winds in Grand Junction increased from 10 mph to 22 mph with gusts up to 30 mph.
- On July 5 and 6 the Haines Index was 6. The Haines Index correlates atmospheric conditions to large fire growth. The highest level of the Haines Index is 6, which shows a high potential for large fire growth.
- Ten red flag warnings were issued for the BLM Grand Junction District between June 1 and July 6, 1994.

Topography (significantly contributed)

- The fire area was very steep and rugged with 50 to 100 percent slopes.
- The terrain in the fire area is broken and rugged with gullies and ravines narrowing sharply at their bottoms.
- The fire was burning on all aspects. The major fire run resulting in the fatalities was on the northwest aspect.
- Elevations on the fire varied from 5,980 to 7,000 feet at the time of the blowup.

Predicted Versus Observed Fire Behavior (significantly contributed)

Predicted

- Extreme and hazardous fire behavior on the South Canyon fire could have been predicted for the passage of the cold front by using fire weather forecasts and information readily obtainable at the BLM Grand Junction District Office and the Western Slope Fire Coordination Center at 7:30 p.m. on July 5.
- The predicted spread and intensities are typical of fires that defy any direct control measures by handcrews, engines, dozers, or air support.
- In reevaluating proposed priorities, strategies, and tactics on the South Canyon fire, the Grand Junction District did not adequately consider forecast fire danger indices for July 6.
- The Weather Information Management System (WIMS) is difficult and time consuming to use.

Observed

- Fire behavior on July 3, 4, and 5 consisted of backing and flanking in the pinyon-juniper fuel type. The fire's main carrier was grass. The fire made short runs back up the hill and occasionally torched pinyon and juniper trees.
- The fire burned actively on the nights of July 4 and 5.
- The fire spread into the Gambel oak late on July 5 and spread through the leaf litter under the brush across and down slope at a rate of 70 feet per hour during the night and morning of July 6.
- A reburn southwest of Helispot 1 in mixed Douglas-fir pinyon-juniper at 3:45 p.m. on July 6 had 100-foot flame lengths.
- The fire crossed to the west side of the west drainage between 4:00 and 4:04 p.m. on July 6 and moved northwest at rates of 1.6 to 2.2 mph (140-195 feet per minute).
- Between 4:14 and 4:18 p.m. the fire spotted back to the east side of the west drainage below the firefighters hurrying up the fireline. Fire behavior intensified as the fire moved from the pinyon-juniper fuel type to the green Gambel oak to the underburned Gambel oak. The rate of spread also increased as the fire moved to a steeper slope with greater exposure to the wind.
- The spot fire grew quickly, accelerating from 3.1 mph (271 feet/minute) to 10.7 mph (941 feet/minute) as it approached the ridgeline. The fire moved from the bottom of the drainage to the ridgeline, covering 1,190 feet in 2 minutes.
- Five minutes after it crested the ridgeline, the fire in the west drainage reached the site of the helitack fatalities.

Indicators Of Drought (significantly contributed)

- Colorado's West Slope was in extreme drought as determined by the Palmer Drought Index. Glenwood Springs had had 8 straight months of below-normal precipitation, and precipitation since October 1993 had been 58 percent of normal.
- The burning index in early July was at the highest level ever recorded for those days in the 21 years of weather records at the Colorado National Monument.

Environmental Factors**Wind (significantly contributed)**

- Winds of up to 45 miles per hour at the time of the blowup caused difficulty in deploying fire shelters.

Smoke (influenced)

- Smoke was not a significant factor before the blowup.
- Heavy smoke during the blowup reduced visibility.

Temperature (influenced)

- Temperature in the fire area ranged from the upper 70s to lower 80s during the afternoon of July 6.

Terrain (significantly contributed)

- The fire area is very steep and rugged with slopes up to 55 percent on the fireline, making foot travel difficult.
- The soil in the fire area is thin, and the ground is covered with many rocks, ranging from pebbles to boulders.
- Throughout the fire area are gullies, ravines, and steep rock outcrops.

Visibility (significantly contributed)

- Firefighters could not see all of the active fire in the west drainage because of the height of the vegetation and the incised drainages that obscured the view to the bottom.

Incident Management

Objectives (significantly contributed)

Policy

- In the Glenwood Springs Resource Management Plan the South Canyon fire area is designated as a Fire Exclusion Zone, an area where all fires are to be fully suppressed. The objective for fire suppression in the Grand Junction District Fire Management Activity Plan for the Fire Exclusion Zone is to have 90 percent of fires controlled at 10 or fewer acres.
- On June 14, 1994, because of fire danger, BLM's Grand Junction District established a policy to suppress all new fires.

District Firefighting Resources

- The initial attack capability of the Grand Junction District consisted of two heavy engines and three light engines, with a total of 12 seasonal employees.
- All air support and additional fire fighting forces were requested from the Western Slope Fire Coordination Center.
- The Grand Junction District has averaged 150 fires per year over the past 5 years with a maximum of 10 new fires in a single day.

Fire Situation

- From June 25 through July 8, 1994, 264 new fires started in Colorado.
- Forty-four new fires were reported in the Grand Junction District in a 3-day period from July 3 through July 5.
- Six of these fires were given the highest priority on the basis of their rate of spread and their threat to gas wells, private land, residences, and a power transmission line along Interstate 70.

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- The South Canyon fire was ignited by lightning on July 2 and was reported to the BLM Grand Junction District on July 3 at 11:00 a.m.
- The Grand Junction District Dispatch Center's belief that the fire might be on private land complicated early actions.
- The legal description of the fire site was accurate in the initial fire report (July 3 at 11:00 a.m.), placing the fire on BLM-administered public lands.
- The fire was assigned a low priority for initial suppression because of multiple fires throughout Colorado, reported light fuels on the site, the fire's small size, and safety concerns.
- Initially the fire was not viewed as a threat to residential structures, but as it spread, it became apparent that if left unabated, it could potentially become a threat.
- Starting the night of July 3, initial attack forces were informally requested to attack the South Canyon fire.
- Initial attack occurred the morning of July 5.
- Reinforcements arrived the night of July 5.
- The Incident Commander was concerned that firefighting activities would dislodge rocks and debris and cause safety problems on Interstate 70.
- Concerns for threats to residential structures in Glenwood Springs and other communities influenced decisions and actions on the fire.
- The fire's priority was increased by mounting public pressure for action, the increased intensity of the fire, and improved resource availability. Fireline construction began on July 5.
- The fire was not considered to have escaped initial attack until 4:30 p.m. on July 6.

Strategy (significantly contributed)

- The strategy was to control the fire using direct attack, starting from the top of the fire.

Tactics (significantly contributed)

- On July 5 the Incident Commander and six BLM/Forest Service firefighters hiked to the top of the fire, started building Helispot 1, and began a direct attack.
- Early on July 6 an order for a fixed-wing aerial observer was filled with Helicopter 93R, which was used for multiple purposes all day.
- On July 6 the Incident Commander and the Jumper in Charge flew the fire in Helicopter 93R and agreed to continue direct attack down the fire's west flank.
- During the day of July 6 Helicopter 93R was used for shuttling firefighters and gear and for bucket drops, limiting the aircraft's effectiveness for aerial observation. Regulations prohibit agency people from riding in helicopters during sling load and bucket operations and thus prevent an onboard observer from being on such flights.

- The Prineville Interagency Hotshot Crew was split into two groups to work both the ridge and the west flank firelines.
- The map drawn during the July 6 morning aerial reconnaissance did not include the fingers of fire in the lower west drainage.
- Strategy and tactics were not adjusted when Type I crews and air support failed to arrive in time on July 5 and 6.
- Tactics were not adjusted in anticipation of a passing cold front.

Safety Briefings And Major Concerns (significantly contributed)

- On July 5 and 6 some firefighters expressed safety concerns about fire tactics and fire behavior.
- Fire weather and red flag warnings were not broadcast over fire radio frequencies, nor were they given to firefighters on the fire.
- The Incident Commander and the smokejumpers programmed their fire radios to receive the NOAA weather broadcast frequency for general weather information. But such information is not oriented toward fire-fighting.
- During a July 6 reconnaissance of the fire, the Jumper in Charge was asked by smokejumpers on the ground where the safety zones in the west drainage were. He replied that there were not any safe areas but there were some sparse areas below.
- Before the blowup on July 6 several smokejumpers discussed the number of 10 Standard Fire Orders and 18 Watch Out Situations that were being compromised.
- Some but not all of the firefighters building and holding the fireline on the ridge knew that Helispot 1 was a safety zone.
- No lookouts were posted.
- Some firefighters were not briefed on escape routes and safety zones. Lacking this knowledge, some of these firefighters chose their own.
- Reports on the fire during its early stages were contradictory. Some reported light fuels with little potential for spread. Others reported high potential for rapid spread with extremely high risk for firefighters.
- The smokejumpers had their jump gear moved from the fire on the morning of July 6 because they expected that the entire drainage might burn.

Instructions Given (significantly contributed)

- Not all firefighters were aware of the suppression plans for July 6.
- The Investigation Team has not been able to find that any of the firefighters received a briefing that included information about a red flag warning.
- The second load of smokejumpers were briefed in Grand Junction about predicted high winds.
- No organized briefing or discussion was held on local fuel types or expected fire behavior.

- The Prineville Interagency Hotshot Crew did not receive any briefings from the time it arrived in Grand Junction.

Control Mechanisms

Span Of Control (did not contribute)

- The Western Slope Fire Coordination Center and the Grand Junction District Dispatch Center expressed a concern for safety of ground and aviation people because of extremely heavy radio traffic on the Grand Junction District frequency.
- Enough supervisors were on the fire to effectively supervise the firefighters.

Radio And Telephone Communications (did not contribute)

- All crews had good radio coverage: one radio for two smokejumpers, one radio for three hotshots, and one radio for three BLM/Forest Service firefighters.
- Firefighters could talk to the Grand Junction District Dispatch Center.
- Ground-to-air communications were good.
- The Incident Commander had good cellular telephone communication with Grand Junction District Dispatch and the Glenwood Springs Fire Department.

Ongoing Evaluations (significantly contributed)

- On July 6 at 9:45 a.m. the Incident Commander and the Jumper in Charge flew the fire in Helicopter 93R, prepared a fire map, and agreed to start a direct attack down the fire's west flank.
- The Incident Commander, Jumper in Charge, and Hotshot Superintendent continued to evaluate fire behavior from the ground but did not adjust strategy and tactics in response to the intensifying fire behavior on July 6.
- Because of higher winds and fire spotting, at about 2:30 p.m. the BLM/Forest Service ground crew and the hotshots started patrolling the ridge for spot fires.

Involved Personnel Profiles

Training/Qualifications/Physical Fitness (did not contribute)

- Firefighters were qualified for the positions they held on the fire.
- Contrary to Forest Service regional policy, some Region 1 smokejumpers had not received refresher fire shelter training.

Operational Period Length/Fatigue (influenced)

- Before July 6, shifts exceeding 12 hours were common for most of the firefighters.

- The Western Slope Fire Coordination Center's helitack crew had worked 26 consecutive days without a day off, with most shifts in that period exceeding 12 hours.

Attitudes (significantly contributed)

- Some firefighters questioned the effectiveness of fire shelters in the fuel type and terrain of the South Canyon fire.
- Some firefighters failed to recognize the capability and limitations of fire shelters and deployment sites.
- Some firefighters questioned the value of fire shelters under any conditions and may not have been carrying shelters.
- Red flag warnings were not given enough importance by the helicopter pilot and the District Fire Management Officer because of the number of such warnings over the recent period.
- People in the Grand Junction District Dispatch Center expressed the belief that most pinyon-juniper fires do not exceed 100 acres in this area.
- The "can do" attitude of the smokejumpers and hotshots compromised the 10 Standard Firefighting Orders and the 18 Watch Out Situations.
- Despite the fact that they recognized that the situation was dangerous, the firefighters who had concerns about building the west flank fireline questioned the Jumper in Charge, but then chose to continue with construction.
- No evidence was found that fire shelters encouraged tactical risk taking.

Leadership (significantly contributed)

- The Incident Commander returned to Glenwood Springs from 5:30 p.m. on July 5 to 8:45 a.m. on July 6 to prepare for the next day. The Jumper in Charge assumed the role of Incident Commander during that period.
- Some firefighters were confused about who was making the decisions on strategy and tactics.
- Command and supervisory firefighters did not use all the expertise they had at hand in predicting potential fire behavior and its relationship to tactics.
- A squad leader and the Jumper in Charge discussed whether they should be building the fireline downhill toward the fire because of concern expressed by smokejumpers about the location of the west flank fireline.
- A squad leader and the Jumper in Charge discussed who should be in charge as conditions worsened.
- Several firefighters played heroic roles during the blowup and escape.

Equipment

Availability (did not contribute)

Personal Protective Equipment

- Except where noted, firefighters were wearing required personal protective equipment, including gloves, boots, hardhats, and aramid (Nomex) shirts and jeans. Sawyers were wearing chainsaw chaps.
- A firefighter who received radiant heat burns on his hands had gloves but was not wearing them.

Fire Shelters

- One or more surviving firefighters may not have brought fire shelters to this fire although they could have obtained them.
- All firefighters who perished were carrying fire shelters.

Performance (influenced)

Personal Protective Equipment

- Although 14 firefighters were overcome by the fire, all personal protective equipment performed within design limitations.
- Three surviving firefighters received radiant heat burns through their clothing and to exposed skin.
- Because of a broken cinch strap on his glove, one surviving firefighter had to remove his glove to deploy his fire shelter.
- The firefighters who perished did not drop their tools or packs while trying to escape. Dropping their tools or packs would have significantly increased their chance of escape.
- When two firefighters began to deploy their fire shelters, most of the west flank firefighters also stopped to deploy their shelters.
- Two flanking line firefighters and two firefighters who had come down from the top ran up the hill from the deployment site. Three of these four firefighters arrived at the top of the hill and survived. The fourth perished close to the top.

Fire Shelters

- Eight firefighters successfully deployed their fire shelters without burns or smoke inhalation.
- One smokejumper survived the entrapment without deploying a fire shelter and did not receive burns or suffer smoke inhalation.
- Twelve firefighters who perished did not have enough time to open their shelters and get under them.
- The two fully deployed fire shelters lay perpendicular to the fire direction, compromising their effectiveness.
- One firefighter deployed a fire shelter over one or two packs with fuses that ignited.
- Two firefighters who fully deployed their fire shelters died of smoke inhalation and heat.

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- Fire shelters were difficult to remove when suspended vertically under packsacks.
- Firefighters could remove their fire shelters with one hand when their shelters were mounted horizontally on their belts or mounted vertically on side locations.

The 10 Standard Fire Orders And 18 Watch Out Situations

Wildland firefighting is a tough, arduous, and often high-risk job. Much effort has been spent to reduce that risk and improve fire safety and eliminate firefighter fatalities. Personal protective equipment (Nomex clothing, fire shelters), and improved communications and fire behavior prediction technology are but a few of the changes that have improved the firefighter's safety margin. Nevertheless, accidents still occur.

What we have learned from investigating wildland fires is that time and time again fatalities can be attributed to one or more violations of the 10 Standard Fire Orders, which were developed in 1957 by a taskforce studying ways to prevent firefighting fatalities.

Shortly after the Standard Fire Orders were incorporated into firefighter training, the 13 Situations That Shout Watch Out were developed. As a result of other accidents, the 13 were expanded to 18 Watch Out Situations. These 18 situations are more specific and cautionary than the Standard Fire Orders and describe situations that expand the 10 points of the Fire Orders. If firefighters follow the 10 Standard Fire Orders and are alerted to the 18 Watch Out Situations, much of the risk of firefighting can be reduced.

The 10 Standard Firefighting Orders and 18 Watch Out Situations were designed to help firefighters recognize and mitigate firefighting risks. They also provide a ready checklist for periodic review as fire action progresses. Every wildland firefighter is instructed in their meaning and application.

- Firefighters who successfully deployed their fire shelters reported difficulty deploying them on steep terrain with high winds.
- Firefighters on the ridgetop failed to recognize areas where fire shelters could have been successfully deployed.
- The location where the firefighter highest up the hill died would have been survivable in a fire shelter.

10 Standard Fire Orders (significantly contributed)

1. Fight fire aggressively but provide for safety first.
 - The tactics as implemented provided for aggressive suppression but overlooked many critical safety factors.
2. Initiate all action in response to current and expected fire behavior.
 - Aggressive attack continued in spite of onsite indicators of extreme fire behavior and increasingly stronger winds.
 - Most firefighters were unaware of or disregarded how intensely

- Gambel oak and pinyon-juniper fuel types burn during extremely dry and windy conditions.
3. Recognize current weather conditions and obtain forecasts.
 - No spot weather forecasts were requested by fire personnel.
 - No onsite weather observations were taken.
 - The Investigation Team could find no one on the fire who knew of the red flag warning predicted to accompany the cold front.
 4. Ensure that instructions are given and understood.
 - Instructions appeared to be fairly straight forward.
 5. Obtain current information on fire status.
 - No one on the fire had a complete picture of the fire's activity and status.
 6. Remain in communication with crew members, your supervisor, and adjoining forces.
 - Radio communications were good.
 7. Determine safety zones and escape routes.
 - Most of the firefighters did not have clear instructions on safety zones and escape routes.
 8. Establish lookouts in potentially hazardous situations.
 - No one could see the part of the fire that presented the most hazard.
 9. Retain control at all times.
 - During the first phases of the fire, supervisors effectively controlled the firefighters.
 - Supervisory control was generally effective given the blowup conditions.
 10. Stay alert, keep calm, think clearly, act decisively.
 - The firefighters were alert, but they failed to adjust strategy and tactics in a timely manner.
 - The firefighters remained calm during the events leading to the blowup.
 - Failure to recognize the indicators of blowup conditions led to the entrapment of the firefighters.
 - Decisive action resulted in the escape of 35 firefighters when the fire blew up.

18 Watch Out Situations (significantly contributed)

1. Fire not scouted and sized up.
 - The Incident Commander and the Jumper in Charge conducted a helicopter reconnaissance of the fire at 9:45 a.m. on July 6. Firefighters on foot also scouted portions of the fire.
 - During the sizeup hazards were not adequately recognized. The map drawn on the reconnaissance flight did not show the fingers on the fire's northwest edge.
2. Country not seen during the daylight.
 - Not a factor.
3. Safety zones and escape routes not identified.

- Most of the firefighters did not have clear instructions on safety zones and escape routes.
4. Unfamiliar with local weather and local factors influencing fire behavior.
 - The firefighters were unaware of the red flag warning predicted for the afternoon of July 6.
 - Most of the firefighters were unaware of or disregarded how intensely Gambel oak and pinyon-juniper fuel types burn during extremely dry and windy conditions.
 5. Uniformed on strategy, tactics, and hazards.
 - Many of the firefighters were unclear or not fully informed on hazards.
 6. Instructions and assignments not clear.
 - Instructions appeared to be straight forward.
 7. No communications link with crew members and supervisors.
 - Radio communications were good.
 8. Constructing fireline without a safe anchor point.
 - The fireline was not secured to a safe anchor point.
 9. Building fireline downhill with fire below.
 - The west flank of the fireline was being built downhill along the edge of the fire following the burned surface fuels.
 - The fire extended farther down the canyon, below and out of sight of the crew.
 - Most of the guidelines for reducing the hazards of downhill line construction in the Fireline Handbook (PMS 410-1) were not followed. These guidelines are listed in Causal Factors.
 10. Attempting frontal assault on fire.
 - Not a factor. The fire had no distinct head.
 11. Unburned fuel between you and the fire.
 - A significant area of unburned aerial fuels lay between the firefighters and the fire.
 - Firefighters were following the burned surface fuels but did not adequately consider the reburn potential of Gambel oak.
 12. Cannot see main fire and are not in contact with anyone who can.
 - No one could see the part of the fire that presented the greatest hazard.
 - Terrain and vegetation blocked many firefighters' view of the main fire.
 - A lookout who could continually view the main fire was not posted.
 13. You are on a hillside where rolling material can ignite fuels below.
 - The west flank fireline was on a steep hillside where rolling material could and did ignite fires below the line.
 14. Weather is getting hotter and dryer.
 - Before the blowup on July 6 the weather was hot and dry.
 15. Wind increases or changes direction.
 - Before the blowup on July 6 the wind velocity increased significantly.
 16. Spot fires frequently cross line.

- During suppression on July 5 and 6 firefighters encountered some problems with spot fires.
17. Terrain and fuels make escape to safety zones difficult.
- The steep terrain and dense Gambel oak made escape to safety zones extremely difficult.
18. Taking a nap near the fireline.
- Not a factor on this fire.

Management Support And Dispatch Coordination

Management Support (Influenced)

- In the Glenwood Springs Resource Management Plan the South Canyon fire area is designated as a Fire Exclusion Zone, an area where all fires are to be fully suppressed. The objective for fire suppression in the Grand Junction District Fire Management Activity Plan is to have 90 percent of the fires controlled at 10 or fewer acres.
- The District Management Team on June 14, 1994, issued the following direction to clarify what appropriate suppression would be based on severe conditions: "We will not monitor fires, but suppress them."
- On July 5, 1994, the Grand Junction District Manager also clarified the priority for suppression: "Due to the prolonged fire danger and fire incidents, it is necessary that all personnel be available to support fire suppression action when called upon by Grand Junction Dispatch."
- Smaller budgets and lower personnel ceilings have reduced the Grand Junction District and Western Slope Fire Coordination Center's firefighting capability.
- In some cases employees have been placed in management positions without the technical expertise to manage the programs they head.

Dispatch Coordination (Grand Junction District and Western Slope Fire Coordination Center) (Influenced)

- District Dispatch procedures were not adequate.
- Fire weather, fire danger, and predicted fire behavior information was not being adequately developed, interpreted or communicated to ongoing fires.
- Dispatch records at the District and Western Slope Fire Coordination Center were not being adequately maintained to permit analysis of how resource orders are placed and filled.
- District and the Western Slope Fire Coordination Center lacked an understanding or acceptance of their relative roles and responsibilities, particularly, in setting priorities and allocating resources.
- Part of the District fire orders for the South Canyon fire were made as informal requests by telephone or in person to individuals in the Western Slope Fire Coordination Center. No records of these informal orders were maintained.

South Canyon Fire

- Lack of documentation of resource needs resulted in inadequate followup by the District or Western Slope Fire Coordination Center to acquire appropriate resources through Regional or National logistics centers. Apparently, there were intermittent opportunities where additional air support was available on July 3, 4, and 5, but they were not used on the South Canyon fire.

Causal Factors

Direct Causes

The Investigation Team determined that the direct causes of the entrapment in the South Canyon fire are as follows.

Fire Behavior

Fuels

- Fuels were extremely dry and susceptible to rapid and explosive spread.
- The potential for extreme fire behavior and reburn in Gambel oak was not recognized on the South Canyon fire.

Weather

- A cold front, with winds of up to 45 mph, passed through the fire area on the afternoon of July 6.

Topography

- The steep topography, with slopes from 50 to 100 percent, magnified the fire behavior effects of fuel and weather.

Predicted Behavior

- The fire behavior on July 6 could have been predicted on the basis of fuels, weather, and topography, but fire behavior information was not requested or provided. Therefore critical information was not available for developing strategy and tactics.

Observed Behavior

- A major blowup did occur on July 6 beginning at 4:00 p.m. Maximum rates of spread of 18 mph and flames as high as 200 to 300 feet made escape by firefighters extremely difficult.

Incident Management

Strategy and Tactics

- Escape routes and safety zones were inadequate for the burning conditions that prevailed. The building of the west flank downhill fireline was hazardous. Most of the guidelines for reducing the hazards of downhill line construction in the Fireline Handbook (PMS 410-01) (see box on next page) were not followed.
- Strategy and tactics were not adjusted to compensate for observed and potential extreme fire behavior. Tactics were also not adjusted when Type I crews and air support did not arrive on time on July 5 and 6.

Safety Briefing and Major Concerns

- Given the potential fire behavior, the escape route along the west flank fireline was too long and too steep.

Downhill/Indirect Line Construction Guidelines

Downhill/Indirect line construction in steep terrain and fast burning fuels should be done with extreme caution. Direct attack methods should be used whenever possible. The following guidelines should be followed.

- The decision is made by a competent firefighter after thorough scouting.
- Downhill line construction should not be attempted when fire is present directly below the proposed starting point.
- The fireline should not be in or adjacent to a chimney or chute that could burn out while a crew is in the vicinity.
- Communication is established between the crew working downhill and crews working toward them from below. When neither crew can adequately observe the fire, communications will be established between the crews, supervising overhead, and a

lookout posted where the fire's behavior can be continuously observed.

- The crew will be able to rapidly reach a zone of safety from any point along the line if the fire unexpectedly crosses below them.
- A downhill line should be securely anchored at the top. Avoid under-slung line if at all practical.
- Line firing should be done as the line progresses, beginning from the anchor point at the top. The burned out area provides a continuous safety zone for the crew and reduces the likelihood of fire crossing the line.
- Be aware of and avoid the "18 situations that shout watch out!"
- Full compliance with "the 10 standard fire orders" is assured.

From Fireline Handbook, PMS 410-01, National Wildfire Coordinating Group, NFES 0065.

- Eight of the 10 Standard Firefighting Orders were compromised.
- Twelve of the 18 Watch Out Situations were not recognized, or proper action was not taken.
- The Prineville Interagency Hotshot Crew (an out-of-state crew) was not briefed on local conditions, fuels, or fire weather forecasts before being sent to the South Canyon fire.

Involved Personnel Profile

- The "can do" attitude of supervisors and firefighters led to a compromising of Standard Firefighting Orders and a lack of recognition of the 18 Watch Out Situations.
- Despite the fact that they recognized that the situation was dangerous, firefighters who had concerns about building the west flank fireline questioned the strategy and tactics but chose to continue with line construction.

Equipment

- Personal protective equipment performed within design limitations, but wind turbulence and the intensity and rapid advance of the fire exceeded these limitations or prevented effective deployment of fire shelters.

- Packs with fuses taken into a fire shelter compromised the occupant's safety.
- Carrying tools and packs significantly slowed escape efforts.

Contributory Causes

The following factors contributed to the entrapment on the South Canyon fire.

Incident Management and Control Mechanisms

- The initial suppression action was delayed for 2 days because of higher priority fires on the Grand Junction District.
- Air support was inadequate for implementing strategies and tactics on July 6.

Support Structure

- The above-normal fire activity overtaxed a relatively small firefighting organization at the Grand Junction District and Western Slope Fire Coordination Center.
- Detailed fire weather and fire behavior information was not given to firefighters on the South Canyon fire.
- Dispatching procedures and communications with the Incident Commander did not give a clear understanding of what resources (crews and air support) would be provided to the fire in response to requests and orders.
- Unclear operating procedures between the Western Slope Fire Coordination Center and the Grand Junction District's fire organizations resulted in confusion about priority setting, operating procedures, and availability of firefighting resources, including initial attack resources (i.e. helitack firefighters, smokejumpers, and retardant aircraft). This lack of definition limited the effectiveness in the timing and priority of the suppression of the South Canyon fire.
- The lack of Grand Junction District and Colorado State Office management oversight, technical guidance, and direction resulted in uncertainty concerning the roles and responsibilities of the Western Slope Fire Coordination Center and the Grand Junction District.

Followup Actions

This report was presented to the Director of the Bureau of Land Management and the Chief of the Forest Service on August 17, 1994. The Director and the Chief have established an Interagency Management Review Team that will review the Investigation Team's accident reports and to develop proposed corrective actions that should be implemented by the agencies to reduce future accidents of this nature.