INVESTIGATIVE

REPORT

OF THE

ENTRAPMENT

REVIEW

TEAM

DANO FIRE

AUGUST 20, 1996

(Final Report September 4, 1996)

REPORT OF THE ENTRAPMENT REVIEW TEAM

Dano Fire

August 20, 1996

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REPORT OF THE ENTRAPMENT REVIEW TEAM

DANO FIRE

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INTRODUCTION

The Review Team spent a significant amount of time trying to balance sensitivity to employees with an accurate assessment of the facts and findings. We want to be sensitive to people's feelings but have to be careful of minimizing the areas where improvement is needed. We finally came to the conclusion that to trade sensitivity for excellence in firefighter safety was a poor trade. The most sensitive thing we can do is honestly portray our findings so that everyone can learn and hazards can be eliminated.

Firefighting is complex and contains many inherent risks that require skill, good judgement and the ability to make time-limited decisions. Because a job contains risks does not mean that we cannot do it safely if we identify and eliminate the hazards. To concede, as an organization, that we cannot do a job safely means that we should not be doing the job at all. To maintain the belief that a job cannot be done safely and still do it, puts us in the untenable position of failing to identify and eliminate hazards, which could result in injury or death.

Like any complex incident, a number of factors acted in cumulative fashion to create and intensify hazards to the firefighters on the Dano Fire. There are few jobs in the Forest Service that contain the elements of risk associated with firefighting. We must approach fighting fires with a passion for safety that allows us to openly critique our every action. The results of a passionate search for excellence in our attitudes, actions, decisions, policies and procedures means saving lives and eliminating injuries. These results far outweigh being uncomfortable with having our actions reviewed and shared with the rest of the fire community.

The definition of entrapment is a situation in which a fire traps people in a life-threatening position with no, inadequate, or compromised evacuation routes or safety zones. An entrapment may or may not involve deploying fire shelters.

We do not want to understate how serious this situation was, even though no one was injured. The entrapment and deployment occurred between a wall of fire and a sheer cliff face. Finding and using a crevice for protection was the result of luck and cool thinking. It is only conjecture what would have happened if the crevice was not available or there would have been a more catastrophic run of fire. All eight firefighters were potentially entrapped as they had no escape from the fire except by helicopter. Five firefighters were evacuated and three firefighters had to deploy their shelters before being safely evacuated.

We are incurring abnormal fire behavior and it has caught people off guard. Since other parts of the country are experiencing entrapments, it is an especially important time to be critiquing ourselves and re-focusing on safe behaviors.


DANO FIRE
POWELL
YELLOWSTONE NATIONAL PARK
120
14
CODY
16
291
120
MEETEETSE
120
TO THERMOPOLIS
BRIDGER-TETON NATIONAL FOREST
DUBOIS
SHOSHONE NATIONAL FOREST
287
26
26
287
LANDER
131
28
257
US Highway
State Highway
Cities
Scenic Byways
Wilderness Areas
District Boundaries

Figure 1

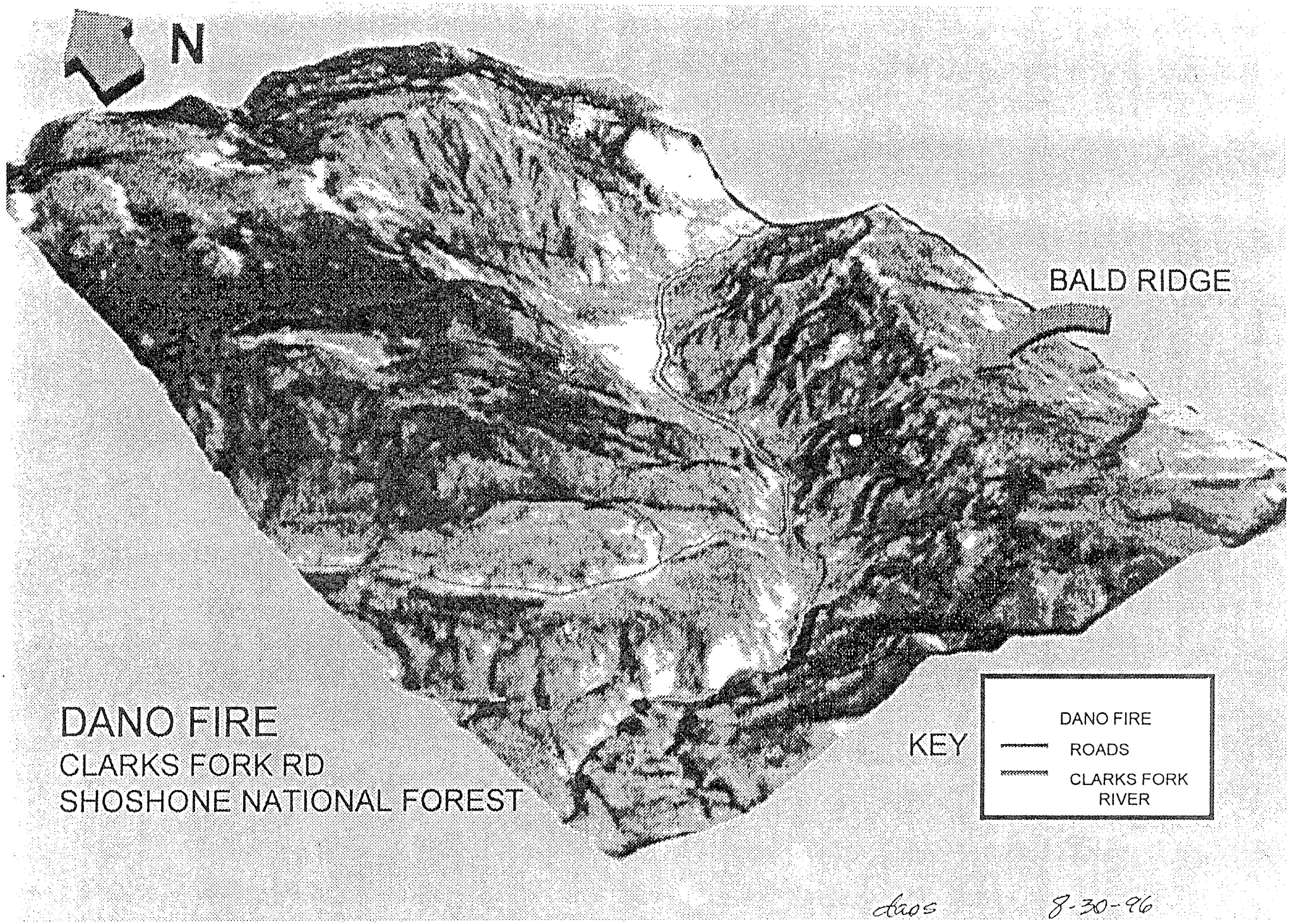

N
BALD RIDGE
DANO FIRE
CLARKS FORK RD
SHOSHONE NATIONAL FOREST
KEY
DANO FIRE
ROADS
CLARKS FORK RIVER
dmos
8-30-96

Figure 2

Dano Fire

Entrapment/Shelter Deployment

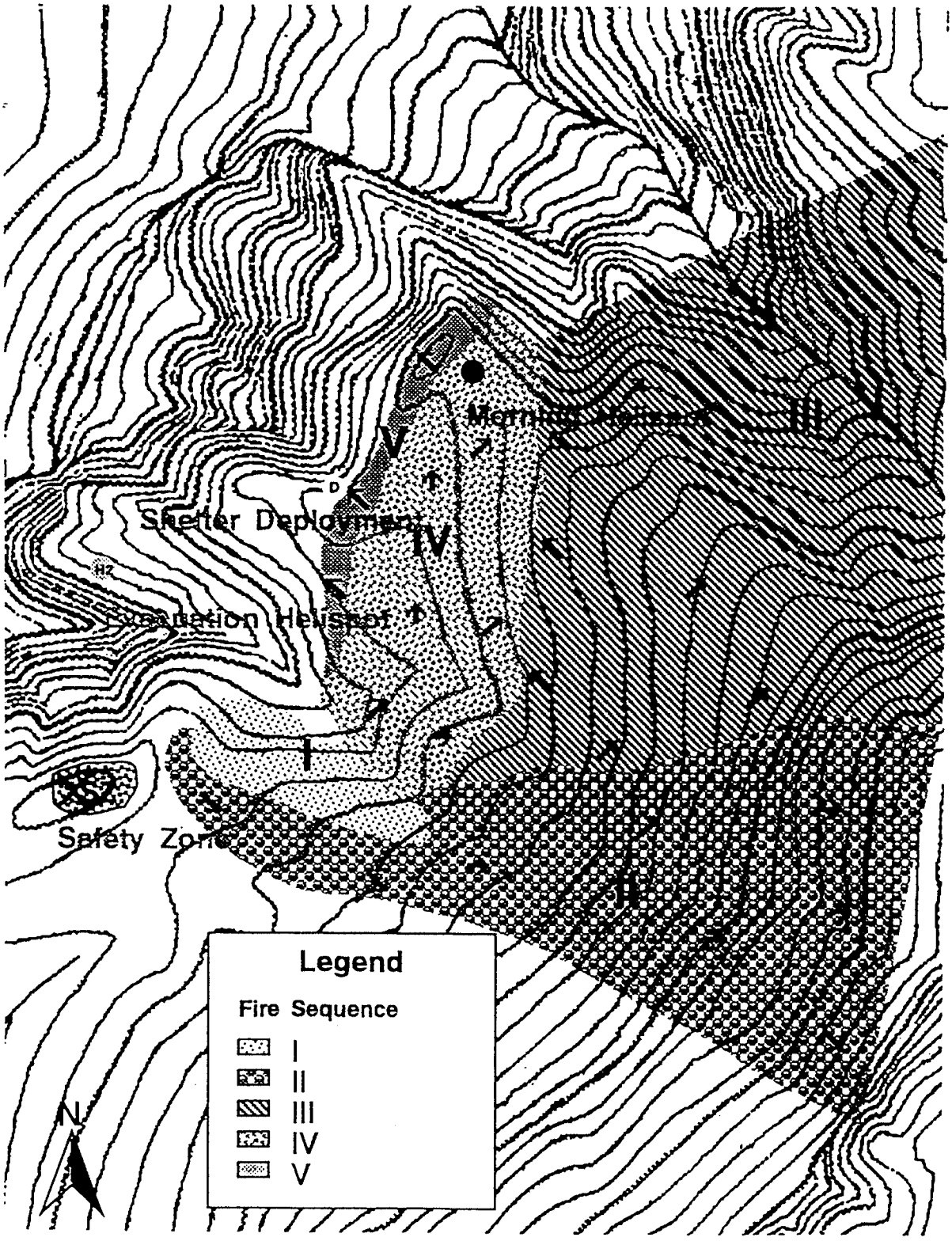


Figure 3

INCIDENT OVERVIEW

The Incident

On August 19, 1996 a lighting-caused fire was reported on the rim of the Clarks Fork Canyon below Bald Ridge on the Clarks Fork Ranger District. On the morning of August 20, seven firefighters and a three person helitack module were dispatched to the fire with [redacted] as Incident Commander. The fire was approximately two acres. The fire was 75% contained by 1100 hours. By about 1300 hours strong winds combined with hot temperatures and low humidity caused the fire to jump the line. By mid afternoon, the fire had grown to approximately 200 acres and was still spreading as the winds continued. The Clarks Fork Canyon is known for high velocity and erratic winds.

Shortly after 1500 hours three firefighters were entrapped by the fire. They deployed their fire shelters in a crevice on a cliff. The firefighters were not injured and all were safely evacuated. After an entrapment and shelter deployment, Forest Service policy requires a review team be brought to the unit to determine the factors and conditions that led up to the entrapment.

Eight firefighters were on the fireline. The fire blew up and cut off their access to the safety zone. Five were removed by helicopter. The fire burned over the helispot before the remaining three could be evacuated, causing an entrapment. The three remaining firefighters had to move into a crevice in a cliff for protection and deployed their shelters. Two air tankers dropped fire retardant to assist in protection of the firefighters.

The firefighters involved in the fire were brought off the fireline for critical incident stress debriefing and interviews.

The Review

A Review Team was formed within one day of the incident to investigate the entrapment on the Dano Fire. The team first met on August 21 and were given their assignments. The team developed a statement of purpose, described the process for critical stress debriefing and began the review. In the next few days the team reviewed the fire and the incident and began a series of interviews with affected personnel. In addition, the team met regularly to discuss progress, clarify assignments, plan the report, and to review findings.

The team finalized the report on September 4, 1996.

REVIEW TEAM STATEMENT OF PURPOSE

1. To identify the causal factors leading to the entrapment and make recommendations.

2. To provide and create an environment of sensitivity and support to
   The Fire Fighting Personnel
   The Incident (Dano Fire)
   The Shoshone National Forest
   The Rocky Mountain Region

3. Communicate lessons learned to the fire community.

FINDINGS

The Dano Fire Entrapment was a near miss. Firefighters were fortunate they were not seriously injured or killed. This section presents the Dano Fire Entrapment Team's findings which are supported by interviews, dispatch logs, physical evidence and other information held at the Shoshone National Forest Supervisor's Office. The Team used the "Fire Entrapment and Review Guidelines," developed by the National Wildfire Coordinating Group. Following these guidelines the team assessed how categories of findings contributed to the incident as "significantly contributed," "influenced," or "did not contribute."

A. FIRE BEHAVIOR

1. Fuels (significantly contributed to the entrapment)

- The primary fuel type involved on August 20 was Douglas-fir and limber pine.
- The live fuel moisture in Douglas-fir and limber pine was 92 percent.
- The 1000 hour fuel moisture was 7.0 to 8.0 percent.
- The one hour fuel moisture was 7.0 percent at 1030 hours. By 1230 hours, one hour fuel moisture had fallen to 3.0 percent.
- The dense Douglas-fir thickets were 25-30 feet tall and were modeled as Fire Behavior Fuel Model 4.
- The open-grown Douglas-fir/limber pine stands were modeled as Fire Behavior Fuel Model 6.

2. Weather (significantly contributed to the entrapment)

- A spot weather forecast was requested at 1000 hours but not received until 1406 hours, well after the fire escaped the initial attack.
- On August 20, the Haines Index was 6. The Haines Index correlates atmospheric instability to large fire growth. The highest level of the Haines Index is 6, which shows a high potential for large fire growth.
- Winds increased after 1200 hours and became strong. Estimated winds at 1500 hours were 20-25 mph.
- Large scale weather patterns in Wyoming and Eastern Montana resulted in large fire occurrence and extreme fire behavior.
- The lower Clarks Fork Canyon experiences frequent, very strong winds. In addition, the general area appears to receive less rain than surrounding areas due to topographic influences.

- The Clarks Fork Canyon is subject to dry, warm, downslope winds.

3. **Topography (significantly contributed to the entrapment)**

- The area in and around the initial attack area was moderately steep and rugged.
- From canyon bottom to top ranged from 4,612' to 8,633' in elevation, a difference of 4,021 feet.
- The fire site had cliffs ranging from 200' to 400' in height both above and below.
- The deployment site was a crevice 10' to 12' deep, 4' wide, 8' to 10' long, on the top of a 350' to 400' vertical cliff.
- The distance from the top of the fire to the safety zone was approximately 600 feet.
- The distance from the top of the fire to Helispot 1 was approximately 1200 feet.

4. **Predicted Versus Observed Fire Behavior (significantly contributed to the entrapment)**

- **Predicted:**

  The predicted flame lengths, rates of spread and long-range spotting are typical of fires that defy direct control measures by handcrews, engines, dozers or other support. (See Appendix 6 Hauling Chart)

  The extreme and hazardous fire behavior on the Dano Fire could have been predicted through the use of current fire behavior prediction systems using available fire weather forecasts.

- **Observed:**

  There were four major runs, Sequence II through Sequence V (See map). Sequence I is the original fire.

  The fire behavior on the morning of August 20, consisted of a smoldering duff fire (Sequence I).

  There was little visible smoke at the time of initial attack.

  Between 1030 hours and 1230 hours, the 1 hour fuel moisture dropped from 7 percent to 3 percent and trees inside the handline began to torch.

  Between 1330 hours and 1415 hours, fire had escaped the initial containment line on the west side and made a run uphill (Sequence II).

  Between 1425 hours and 1430 hours, a slight wind shift occurred pushing the fire east/ southeast at rates averaging 1-2 mph. Flame lengths were 50 to 80 feet in dense Douglas-fir (Sequence III).

At 1435 hours, the fire had spread into small drainages north and northeast of Sequence I, where it made a run to the north at a rate of 2.1 to 2.3 mph toward Helispot I (Sequence IV). The fire took approximately 6 minutes to travel the 1100 feet to where it burned past Helispot 1. The intensities seen in Sequence IV were pulled uphill and to the right as Sequence III and IV met on the slope above Helispot 1.

As Sequence IV cooled, there was a strip of unburned fuel remaining between Sequence IV and the rock cliff that ignited at 1505 hours. This run was burning in more open timber and rates of spread were .5-.6 mph. Intensities were also less. Shelters were deployed at 1512 hours. There were several fire runs toward the deployment site and re-deployment occurred at 1515 hours.

B. ENVIRONMENTAL FACTORS

1. **Wind (did not contribute to the entrapment)**

2. **Smoke (did not contribute to the entrapment)**

3. **Temperature (did not contribute to the entrapment)**

4. **Terrain (significantly contributed to the entrapment)**

- Cliffs, rocks and steep slopes above and below the immediate fire area made escape nearly impossible.

- The rock and steep slope between Sequence I and the entrapment site made travel moderately difficult.

- The cliffs and rock outcrops made finding a suitable entrapment area difficult.

- The size and depth of the crevice made shelter deployment moderately difficult.

- The depth of the crevice added to the survivability of the site.

5. **Visibility (did not contribute to the entrapment)**

- Visibility was good until the time when the lookout was flown out by the helicopter at 1445 hours. After 1445 hours, visibility was poor and firefighters could not see the direction of travel of the fire.

C. INCIDENT MANAGEMENT

1. *Objectives* **(did not contribute to the entrapment)**

Policy

- All fires in the Clarks Fork canyon area are subject to suppression utilizing the appropriate suppression response as per the Shoshone Fire Management Action Plan and the enacting legislation which designated the Clarks Fork Wild and Scenic River.

- The Forest Service Manual FSM 5121.1 requires that Fire Management Action Plans (FMAP) be developed at the Forest level, and be updated and adjusted annually. While the Forest has developed a FMAP and portions are excellent, such as fire team transition, there are no clear provisions in the plan to reflect "current conditions." This makes transitions to a more complex fire management staffing difficult. Also, trigger points that necessitate or indicate changes in fire severity or fire management response are unclear and no provision for fire severity is identified until fire preparedness level 5 is reached.

Available Resources

- The initial attack capability of the North Zone of the Shoshone National Forest consisted of two light engines with a total of six seasonal employees and one ICT4 with collateral duties in timber.
- A helicopter module (3 person) was ordered from the Cody Interagency Dispatch Center to assist in logistics and suppression activities.
- The Shoshone National Forest averages 26 fires per year and occasionally will have multi-fire occurrences.
- The Forest FMO is also the North Zone FMO and supervises one light engine.
- Seven Forest personnel are red carded as ICT4 for initial attack.
- There are agreements in place in the Greater Yellowstone Area (GYA) to share fire suppression resources.
- Thirty-two (32) percent of the entire forest workforce is red carded.

Fire Situation

- The Shoshone Forest was experiencing an average number of fire starts (15).
- Cody Interagency Dispatch Center normally handles 2 project fires per year for the state of Wyoming. This year they handled 10 project fires up until the Dano Fire.
- In 1996 the Western U.S. has been experiencing extreme fire behavior in a number of fires. This situation has been observed over the summer moving from Arizona/New Mexico through Colorado and into Wyoming and Montana.
- This fire was recognized as being a dangerous fire and reasonable access was by helicopter only.

2. *Strategy* **(significantly contributed to the entrapment)**

- The strategy was determined on the night of August 19th, shortly after the fire was reported and observed by the Clarks Fork engine crew.

- After initial intelligence, the FMO and the Incident Commander discussed the strategy and determined that the fire should be direct attacked using a helicopter and the Wapiti and Clarks Fork engine crews.

- The plan was for the fire to be contained before afternoon temperatures warmed and winds picked up.

- There was no provision in place if the fire was not contained before afternoon temperatures warmed and the winds picked up.

- There was no strategy developed for either a go/no go initial attack of the fire or to use an ICT3 qualified Incident Commander for initial attack.

3. *Tactics* **(did not contribute to the entrapment)**

- The Incident Commander reconnoitered the fire from both the air and ground before crews arrived at the helispot. The fire was estimated to be 1 to 2 acres in size and was not demonstrating any unusual fire behavior.

- The Incident Commander sized up the fire and determined tactics utilizing general weather information without fuel moisture content or expected fire behavior information.

- Based on scouting and size-up, direct attack was employed using 8 people with hand tools.

- Hand line was anchored near the base of the rock safety zone.

- Helicopter was used to deliver blivets by sling and for bucket drops.

- Mop-up using a pump and hose lay from blivets was set up along the line.

- Crews were instructed to position themselves around the line where they were to hold and improve the line and handle slopovers.

- When fire activity increased at approximately 1230 hours the helicopter was used to cool flare ups.

4. *Safety Briefings and Major Concerns* **(did not contribute to the entrapment)**

- The Incident Commander and the Forest FMO discussed safety concerns about the fire due to potential erratic winds and steep terrain.

- The Incident Commander gave the crew a briefing before starting on line construction which included the identification of the safety zone and escape route.

- The briefing did not mention a contingency plan in the event the fire was not contained early.

- The helitack module and pilot were not given a briefing on strategy, tactics, or safety before engaging in suppression activities.

- The Incident Commander realized the difficulty in maintaining the escape route because of fuel and terrain, and as a result, directed the crew to widen the fireline.

- The Helitack foreman had expressed concern about the lack of resources to several of the crew members, but not to the Incident Commander.

- There was some confusion among those working the fireline about location of safety zone and escape route.

- The Incident Commander requested a spot weather forecast at 1000 but did not receive the forecast until 1406. Cody Interagency Dispatch Center (CIDC) did not provide the forecast in a timely manner and the Incident Commander did not follow up on the request.

- The Incident Commander positioned a lookout in the safety zone where he had a very good view of the fire. The lookout was also directed to take weather readings every half hour which were relayed to the Incident Commander and crew. The Incident Commander requested acknowledgement of RH by the crew members when it dropped below 15%.

5. ***Instructions Given*** **(did not contribute to the entrapment)**

- All firefighters were not given a full briefing before engagement at the fire.

- The briefing did not cover fuel type or expected fire behavior.

D. CONTROL MECHANISMS

Span of Control - **fire program organization: (significantly contributed to the entrapment)**

- Since 1993 the Forest has made progress in developing a fire organization that will meet land resources objectives in a safe manner during fire suppression operations.

- A full-time Forest FMO and a South Zone FMO have been added since 1993.

- The Forest FMO served dual roles by providing both operational and large picture oversight in the initial attack phase.

- Trend analyses are not being accomplished.

- Live and dead fuel moistures data are not being collected.

- Threshold levels for extreme fire behavior are not clearly identified in FMAP and are therefore not being used to transition between preparedness levels, nor being used to request fire severity funds and resources.

- FMAP does not specify what actions are needed during multiple fire occurrence or peak fire conditions.

Span of Control - **Incident management/ongoing evaluations: (Significantly contributed to the entrapment)**

- Enough supervisors were on the fire to effectively supervise the firefighters.
- The Incident Commander's collateral duties and priorities did not provide enough time to stay current on fire weather.
- The fire was sized up from both the air and ground with a lookout positioned to monitor the fire and weather and to report changes as they occurred.
- An accurate assessment of predicted fire behavior necessary for the development of strategy and tactics for the Dano Fire could not be completed without critical fuel moisture information and forecasted fire weather.
- There was an easily visible safety zone that was identified by the incident commander. (Rock Knob/Lookout)
- The rock knob was the only safety zone available and may have been so obvious that consideration was not given to an additional safety zone.
- The identified safety zone was inadequate for the entire fire area as it was only reachable from the bottom of the fire.
- An alternative escape route to the original safety zone from the top of the fire was not feasible nor was it timed, scouted or walked.
- As the fire moved to Sequence II, it quickly went beyond the capability of available fire suppression resources.
- As the fire moved to Sequence II, Incident Commander Dawson directed the crew to the rocks near Helispot 1 believing their escape route had been cut off.
- Once the firefighter's escape route was cut off, there were no safety zones. Any downhill escape was prevented by the sheer cliff.
- Observing the fire run in Sequence II from the rocks near helispot 1, the crew did not feel threatened. The fire was moving uphill and away from them.
- From the time the crew left the fireline, as a result of Sequence II at 1330 hours, there was approximately 40-80 minutes before Helispot 1 was overrun by fire.
- Helicopter transport time during evacuations could have been cut in half by using closer available landing zones.
- The helicopter was used for a 5 to 10 minute recon when it could have been used for evacuation. The order to evacuate was given after recon was completed.
- The decision to move into the crevice and deploy shelters saved lives.

Radio and Telephone Communications **(did not contribute to the entrapment)**

- There were intermittent problems with the direct forest radio frequency due to microwave problems. There was good radio coverage for the fire through the Clarks Fork District Office.

- Radio access on the fire was excellent with each fire member having a personal portable radio. Ground to air communications were adequate.

E. HUMAN FACTORS

TRAINING/QUALIFICATIONS/PHYSICAL FITNESS **(did not contribute to the entrapment)**

- All firefighters were qualified for the positions they held on the fire.
- The engine supervisors within the north zone did not meet the single resource crew boss qualifications.
- All firefighters had attended a Standards for Survival refresher course.
- The Shoshone Forest has 157 permanent and seasonal employees. 21 permanent and 46 seasonal employees (67 total) had taken the refresher course in 1996.
- The forest FMO is Task Force and ICT3 qualified.
- IC[redacted] is Crew Boss and ICT4 qualified.

FATIGUE **(did not contribute to the entrapment)**

- Fatigue was not a factor.

ATTITUDES **(Influenced the entrapment)**

- Firefighters actions were based on historic fire experience rather than the indicators that predicted a potential for extreme fire behavior.
- The helitack supervisor had concerns about crew size, rugged terrain and predicted weather conditions, but did not mention these to the Incident Commander. Helitack Supervisor was reluctant to make suggestions because he did not want to feel like he was undermining the Incident Commander's authority or command. He did mention his concerns to the fireline crew at helibase. Response from the crew was that they were tough and could handle it fine.
- The crew thought they had the fire "whipped" at lunch time.
- The belief on the Shoshone National Forest is that they have a few, small fires that are easy to put out. This attitude is held by the leadership on the Forest, which reinforces the attitude among firefighters.
- There are some perceptions on the forest that fires cannot be fought safely.

LEADERSHIP **(did not contribute to the entrapment)**

- There was no confusion about leadership on the fire.

F. EQUIPMENT

AVAILABILITY (did not contribute to the entrapment)

- Personal Protective Equipment
  Fire fighters were wearing required personal protective equipment including gloves, hardhats, boots, nomex shirts and jeans. Sawyer was wearing chaps and ear/eye protection.

- Fire Shelters
  All firefighters were carrying shelters. The three firefighters who deployed their shelters carried them with them until they could be evacuated.

G. 18 WATCHOUT SITUATIONS

1. **Fire not scouted and sized up.** The Incident Commander did a good job of scouting the fire from the air and on the ground. However, his size up was based on a lack of information about fire weather, live and dead fuel moistures.
   (This situation significantly contributed to the entrapment.)

2. **In country not seen in daylight.** Not applicable on this fire.
   (This situation did not contribute to the entrapment.)

3. **Safety zones and escape routes not identified.** Safety zones and escape routes were identified to fire crew members by the incident commander. The escape route was not adequate for the entire fire. With the escape route cut off by the fire, there was no safety zone.
   (This situation significantly contributed to the entrapment.)

4. **Unfamiliar with weather and local factors influencing fire behavior.** The Incident Commander knew canyon influences such as strong and erratic winds and steep slopes. The Incident Commander did not have weather indices (maximum/minimum humidity and temperature trends, energy release components, manning class levels, etc.). The Incident Commander did not have a general or spot weather forecast. The Incident Commander did not know live and dead fuel moistures.
   (This situation significantly contributed to the entrapment.)

5. **Uninformed on strategy, tactics and hazards.** The helitack crew member who remained to help with the fire did not receive a strategy, tactics and hazards briefing. All other fireline personnel received the briefing.
   (This situation did not contribute to the entrapment.)

6. **Instructions and assignments not clear.** Instructions to all fire crew members were clear. The helitack crew and pilot did not receive a strategy, tactics, and hazards briefing.
(This situation did not contribute to the entrapment.)

7. **No communications link with crew members/supervisors.** Each member on the fire had a personal portable radio. Communications between the incident commander and the crew members were good.
(This situation did not contribute to the entrapment.)

8. **Constructing line without a safe anchor point.** Line construction was started with a safe anchor point.
(This situation did not contribute to the entrapment.)

9. **Building fireline downhill with fire below.** Some downhill fireline construction occurred on spot fires during the morning while fire activity was minimal and the weather was cooler.
(This situation did not contribute to the entrapment.)

10. **Attempting a frontal assault on the fire.** Not applicable on this fire.
(This situation did not contribute to the entrapment.)

11. **Unburned fuel between you and the fire.** Not applicable on this fire.
(This situation did not contribute the entrapment.)

12. **Cannot see main fire, not in contact with anyone who can.** A lookout was posted with a good view of the fire and communicated changes in fire conditions to the incident commander as they occurred.
(This situation did not contribute to the entrapment.)

13. **On a hillside where rolling material can ignite fuel below.** The fire was located on a steep slope in which rolling material did result in 2 slopovers. However, the 2 slopovers were controlled.
(This situation did not contribute to the entrapment.)

14. **Weather is getting hotter and drier.** The fire occurred on a steep northwest facing slope in a canyon. Fire behavior was calm until the angle of the sun began to heat the fire area. Fire behavior significantly increased as the temperatures became hotter and the relative humidity dropped. Relative humidities were dropping 5% every half hour from 1030 to 1230. The probability of ignition increased from 50% to 90% in 2 hours, (1030-1230). One hour fuel moisture dropped from 7% to 3% in 2 hours, (1030-1230). The Incident Commander did not adjust to these factors.
(This situation significantly contributed to the entrapment.)

15. **Wind increases or changes direction.** Increased fire behavior occurred as the wind speed increased and became erratic.
(This situation significantly contributed to the entrapment.)

16. **Getting frequent spot fires across the line.** Spotting from Sequence II resulted in the fire moving toward Helispot 1 and the Deployment Site.
(This situation significantly contributed to the entrapment.)

17. **Terrain and fuels make escape to safety zones difficult.** As the fireline was constructed from the anchor point toward the top of the fire, the escape route to the safety zone became inadequate. As Sequence II blew up, the escape route was cut off.
(This situation significantly contributed to the entrapment.)

18. **Taking a nap near the fireline.** Not applicable on this fire.
(This situation did not contribute to the entrapment)

H. 10 STANDARD FIRE ORDERS

1. **Fight fire aggressively but provide for safety first.** There was a strategy, tactics, and hazards briefing prior to beginning work on the fire. Safety measures were adequately addressed. However, predicted fire weather and information about live and dead fuel moistures was not part of the size up.

   The escape route that was identified became inadequate as the fireline was constructed toward the top of the fire. There was adequate time to remove all personnel from the fire (40 to 80 minutes) before Sequence IV made evacuation impossible. This time was not capitalized on.
   (This order significantly contributed to the entrapment.)

2. **Initiate all action based on current and expected fire behavior.** There was not an accurate assessment of expected fire behavior. This was due to missing critical live and dead fuel moisture readings and fire weather information. Actions were not taken based upon conditions relayed from the lookout.
   (This order significantly contributed to the entrapment.)

3. **Recognize current weather conditions and obtain forecasts.** The Incident Commander was unsure of current fire weather indices. The Incident Commander requested a spot weather forecast at 1000 hours. Cody Interagency Dispatch Center did not provide the forecast until 1406 hours. The Incident Commander did not follow up on the request.
   (This order significantly contributed to the entrapment.)

4. **Ensure instructions are given and understood.** Instructions covering the operational phases of the fire suppression job were well done.
   (This order did not contribute to the entrapment.)

5. **Obtain current information on fire status.** A lookout was posted with a good view of the fire. The lookout reported weather on every half hour and changes in fire activity as they occurred.
   (This order did not contribute to the entrapment.)

6. **Remain in communication with crew members, your supervisor and adjoining forces.** Each member on the fire had a personal portable radio. Communications between the incident commander and the crew were good.
(This order did not contribute the entrapment.)

7. **Determine safety zones and escape routes.** The escape route was not adequate from the top of the fire. With the escape route cut off by the fire, there was no safety zone.
(This order significantly contributed to the entrapment.)

8. **Establish lookouts in potentially hazardous situations.** A lookout was posted and could adequately observe the entire fire.
(This order did not contribute to the entrapment.)

9. **Retain control at all times.** The incident commander was clearly identified and gave clear instructions.
(This order did not contribute to the entrapment.)

10. **Stay alert, keep calm, think clearly, act decisively.** The Incident Commander failed to recognize deteriorating conditions in time to prevent a near catastrophe.
(This order contributed significantly to the entrapment.)

I. MANAGEMENT SUPPORT AND DISPATCH

DISPATCH COORDINATION **(Influenced the entrapment.)**

There are no standard dispatching procedures at Cody Interagency Dispatch Center for the cooperating agencies.

Cody Interagency Dispatch Center did not provide the Incident Commander with spot weather information in a timely manner.

CONCLUSIONS AND RECOMMENDATIONS

1. CONCLUSION
Firefighter safety was not provided for on the Dano Fire since several safety practices and precautions identified in the Watch Out Situations and Standard Fire Orders were not followed or mitigated.

RECOMMENDATION:
Forest Supervisor and Regional Forester should reiterate the importance of adopting and following a Safe Practices Code of Conduct for Fire Suppression Operations as outlined in the Chief's 1200/5100/5700 letter of February 7, 1995. Further, the Dano Fire Entrapment/Shelter Deployment situation should be developed into curriculum to be used in basic firefighter training and critical refresher fire training on the Forest/Region.

2. CONCLUSION
Management failed to provide the firefighters with comprehensive fire information such as live and dead fuel moisture and trend analysis for fire weather indices.

RECOMMENDATION:
The Forest Supervisor should establish a plan to monitor live and dead fuel moistures. Included in this plan will be a process which explains to firefighters what the fuel moistures mean as it relates to fire behavior. This plan should be documented in the Forest Fire Management Action Plan.

3. CONCLUSION
Management failed to ensure that the evolution of fire preparedness is commensurate with the fire threat for periods of extreme fire behavior and activity. There are attitudes on the unit that suggest that fires are small and easily suppressed. In addition, some feel that firefighting is inherently unsafe.

RECOMMENDATION:
The Forest Supervisor should revise the Forest Fire Management Action Plan to ensure critical preparedness elements are in place such as: fire severity funding, increased staffing for incident oversight, increased initial attack resources, and local fire behavior summaries.

A Type III Incident Management Team should be established with resources from partner agencies for periods of increased fire activity. The process to provide for an Type III Incident Management Team should be documented in the Forest Fire Management Action Plan.

Trigger points for fire severity consideration should be considered before preparedness level 5.

4. CONCLUSION
The current qualifications and organizational staffing on the Forest is not sufficient to provide for adequate fire management oversight on the Forest during periods of extreme fire behavior and peak activity.

RECOMMENDATION:
Forest Supervisor should develop a fire organization within NFMAS funding that will provide for adequate operational oversight at all times. Develop Division Supervisor qualifications on the forest.

5. CONCLUSION
There is no process in place to ensure for the dissemination of critical fire information to the fireline.

RECOMMENDATION:
Forest Supervisor should work with partners to develop a dispatch plan that will ensure that spot weather forecasts, zone forecasts, red flag warnings, fire danger ratings, and other fire weather information are disseminated to firefighters in a timely manner.

6. CONCLUSION
Cody Interagency Dispatch Center does not have a standard Initial Attack Dispatch Plan for the Forest.

RECOMMENDATION:
Forest Supervisor should develop a standard initial attack dispatch plan for the Forest.

GENERAL RECOMMENDATIONS:

RECOMMENDATION:
Forest Supervisor should comply with regional policy developed in response to WO Fire Review of the Rocky Mountain Region, particularly in the following areas:

1. Identify critical initial/extended attack seasonal personnel that can be converted to permanent employees to provide safety oversight in suppression activities.

2. Provide for clear trigger points for fire severity support.

3. Document preparedness level checks.

4. Work towards developing an action plan to red card 75% of the workforce.

RECOMMENDATION:
Regional Forester should provide adequate oversight to ensure preparedness checks are accomplished.

APPENDIX 1
DANO FIRE CHRONOLOGY

ENTRAPMENT CHRONOLOGY
DANO FIRE

This chronology was developed using fire fighter interviews and dispatch logs. Acknowledging that when fighting fire it is difficult to watch the time, we tried to match events to transmissions in the dispatch log. Times that are estimated in some fashion are indicated by an *. The exact times are not significant, but the time spans and order of the events are important to reconstructing as accurately as possible what led up to the entrapment and deployment of shelters. There was no attempt to capture all the events, but the events we thought were significant to the entire incident.

8/20/96

0805 - Clarks Fork District office contacts CIDC and informs them that IC [redacted] has been trying to make contact. Clarks Fork agrees to flight follow which will begin in 5 minutes.

0810 - IC [redacted] takes recon flight of fire with [redacted]. Fire activity was low. Had hard time finding fire. not much smoke. H180 (Helicopter 180) lands at HS1 (Helispot 1) and IC [redacted] begins on-the-ground size-up. H180 returns to HB (Helibase) to begin transport of crews to HS1.

- IC [redacted] flags line to fire roughly on the contour. ID'd fuels, slopes. Walked the perimeter of the fire. Walked escape route to safety zone. Located anchor point at rock outcrop for line construction. Flame lengths 1-2 feet on E&N flank. No other flameoln remainder of fire. South and west flank, no visible smoke. Winds light coming up draw.

0900 - Crew is at HS1 IC [redacted] instructs [redacted] to bring crew over following IC [redacted]'s flagline.

0910 - IC [redacted] briefs crew on fireline of tactics, safety zone, escape route. Instructs crew where to start line and the route to follow, to build a wide line to use for escape route to safety zone. Identified safety zone as rock knob to SW. Assigned [redacted] as lookout and instructs him to go to rock knob in safety zone and position himself where he has a good vantage point of fire. Instructed Stephens to take weather reading when he arrives and relay to CF and then on to CIDC for spot weather forecast. Then continue to monitor weather and relay to [redacted] every 30 minutes. Informed everyone that strong winds could be expected in canyon and to be cautious.

0926 - IC [redacted] contacts CF office and reports the fires is 1-2 acres in size, crew is beginning to line, [redacted] began working with crew until H180 started bucket work.

1000* - [redacted] informed IC [redacted] of RH 31%, dry bulb 69. Fire extremely quiet. [redacted] requested spot weather forecast thru CF office to CIDC approx. 1000.

1100 - [redacted] reported to IC Dawson- RH 26%.

- Line 90% complete ([redacted] [redacted] est 75%)

- H180 had dropped 8-10 buckets of water.

1130* - H180 refueled and brought in 2 blivets and pump and 1000' of garden hose. Placed one near head of fire other near bottom, just about the anchor point.

1200 - Had folks take a breather and eat lunch.

- [redacted] radio'd IC [redacted] RH21%, DB 78. Inversion had lifted and fire activity started to pick up.

- H180 slung add'l blivets and mop up kit into fire.

1230 - Shut H180 down from bucket drops due to safety concerns for crew. Felt could handle mopup with water available.

- [redacted] reports RH 18%, DB 82, trees began to torch within containment line, notified IC [redacted]

- Located slop over at NE corner. (up in draw) Put [redacted] on it.

- IC [redacted] located another slop over in N corner (down in draw below anchor point). Directed [redacted] to cool it down w/water.

- IC [redacted] requested H180 to return with bucket and cool down flare-ups.

1300 - [redacted] informed IC [redacted] RH 15%, DB 85.

- [redacted] requests radio acknowledgment from all crew members.

- H180 drops 2 buckets.

- Fire building intensity.

- Ordered crew out of draw to blivet staging area @ head of fire.

- Winds picked up. Blowing up canyon to S

- H180 aborts 3rd bucket drop due to winds.

1315 - Sequence II (first run) begins. (Sequence I is the original fire.

- Escape route cut off.

- Orders crew back to HS1 as fast as possible. [redacted] leads crew, except for [redacted] in safety zone.

1340 - IC [redacted] requests availability of air tankers. "Fire made run and we had to get back from it." [redacted] out of wind (Larson heard on radio).

- IC [redacted] ordered everyone to open area to the West of HS1, on the rocks, and [redacted] further up the rocks in the safety zone for safety.

1342 - CIDC ordered 2 air tankers (127, 06) and 1 lead plane(LB2)

1401 - Fire makes major run upslope to the east. IC [redacted] estimates 20 acres. Still in sequence II.

1406 - Spot weather forecast read to IC [redacted]

- IC [redacted] estimates fire at 50-60 acres. (Sequence II)

1414 - IC [redacted] takes recon of fire in H180 with [redacted]. Estimates fire size at 100 acres.(Sequence II)

1424* - (10 min recon flight?).

- IC [redacted] thru [redacted] had [redacted] request to [redacted] to send three people for transport to HB. ([redacted])

1428 - IC [redacted] directs [redacted] to pick up [redacted] at the safety zone and transport to HB and return for [redacted] and H180 had to attempt several landing sites before finally evacuating [redacted]

- Sequence #2 was still running up the hill.

1430 - Within minutes Sequence #3 began moving across slope.

1445 - Sequence #4 made its run. IC [redacted] coordinating with LB2 while [redacted] clearing trees and debris from rock outcropping for potential deployment site.

1452 - Lead Bravo 2 (LB2) is on scene.

- LB2 reports (and video) indicates that the entire bench was engulfed.

- In LB2 first pass they could not locate the crew, but estimated that there was 20 feet of fuel between the fire and the edge of the rock and about 20 feet of rock to the cliff's edge.

- On the second pass LB2 Air Attack located one person

- On the 3rd pass LB2 pilot located one person in crevice. Fire was lapping against rocks.

1510 - (Possibly a little earlier) H180 returns to fire and sits on knob to clear the airway for tankers and lead plane.

- Tanker 127 dumps first load in draw south of crevice.

1517 - IC [redacted] orders Crew to shake out shelters. [redacted] suggests using a crevice directly below area cleared. Crew gets into crevice and IC [redacted] instructs crew to put feet into shelters and get positioned for pulling shelter over head should fire make a run at their location.

1515 - Tanker 06 drops 2nd load north of crevice.

- IC [redacted] leaves crevice to see where load dropped and size up fire activity. Fire makes a run at their location from the East and he returns to crevice and re-deploys shelter over his feet.

1519 - LB2 reports to CIDC that they used 2 tankers to support the crew. Dawson on cliff and OK.

1520 - Wind shifts and fire moves away. H180 over head looking for spot and tells crew to remove trees for evacuation of personnel. Evacuation location approximately 50 feet SW of crevice.

- H180 returns to HB for fuel.

1525 - Tried to clear tress with a pulaski. Fire makes another run from the East. IC [redacted] directs crew to go to bench below and SW of deployment site.

1530* - H180 returns. Pilot requests IC [redacted] and crew move to HS2 but needed saw to remove trees.

- H180 returns to HB to get saw.

1545* - Returns to HS2 with saw and Mitchell lowers saw to crew with parachute cord.

1545*- 1609* - Crew improves HS2.

1609 - LB2 communicates to dispatch that IC [redacted] and crew have been evacuated from fire by H180.

1616* - Crew arrives at HB.

APPENDIX 2
REVIEW TEAM CHRONOLOGY

FIRE BEHAVIOR NARRATIVE
DANO FIRE AUGUST 28, 1996
JERRY CHONKA, FIRE BEHAVIOR ANALYST

The Dano fire started on either August 17 or 18, 1996. IAMS lightning maps from Cody Interagency Dispatch Center identified lightning in the area of the fire start both days. Recon of the fire on the evening of August 19, 1996 determined the fire size at 1-2 acres. This portion of the fire is called SEQUENCE I. The fire had made a uphill run on a ridge moving to the east and some trees had torched. These torching trees may have caused some spot fires outside the main perimeter of the fire. Indications are that the northern portions of the fire was a backing fire moving downslope (char pattern on trees flat, no torching of trees, and rolling debris). At 0900 August 20, 1996, the fire size had not changed much and in fact, the initial helicopter flight to the fire had some trouble locating the fire due to lack of smoke.

The surface fuel bed within and adjacent to the Dano fire is described as FIRE BEHAVIOR FUEL MODEL 8 (compacted needle bed with occasional pockets of heavy fuels). There was a component of moss on the forest floor that may have raised flammability and added an inch or two to the fuel bed depth. The moss did not contribute greatly to increased fire behavior but may have allowed the fire to spread easier. Comments made by suppression personnel indicated that some portions of the fire were not burned clean. This "dirty burn" pattern is common with Fuel Model 8 head fires. Duff/litter layers under Douglas-fir and limber pine averaged 2"-4" and under older trees with large crowns, duff/litter layers ranged from 4 inches to 12"+. The timber stands around the Dano fire consisted of dense, small-diameter Douglas-fir (FIRE BEHAVIOR FUEL MODEL 4) and more open-grown, larger diamenter Douglas-fir and limber pine (FIRE BEHAVIOR FUEL MODEL 6). There were small opening of grass and sagebrush within the burn area but these areas had little if any effect on the overall fire behavior. On August 22, 1996, live fuel samples were collected from the Dano Fire. These samples were oven-dried at the Cody Interagency Dispatch Center and had the following readings: DOUGLAS-FIR 92.0%, LIMBER PINE 92.6%. The samples were comprised of older needles and did not include any 1996 new growth. In zddition, several representative 1000 hr. fuel locations were looked at. These included deep duff layers and large logs. It is my professional option that the 1000 hr. fuel moisture in and around the Sequence I area is 7.0% to 8.0%. I checked with Cody Interagency Dispatch Center on 08/27/96 on what some of their 1000 hr. dead fuel moistures have been. As of the last sample date (8/15/96), their 1000 hr. fuel samples have been running from 6.5% to 8.8%.

As the initial attack activity started around 0900, smoldering fires were burning in the duff/litter layers. A spot weather forecast was requested by the Incident Commander at 1000 hours but not recieved until 1406 hours. The following is the Dano Fire 1 hour and Probability of Ignition values for 8/20/96 based from on-site weather readings taken by Erich Stephens:

TIME	RH%	TEMP	1 HR	PI
1030	31	69	7.0	50%
1100	26	75	5.5	55%
1130	26	75	5.0	60%
1200	21	78	4.0	70%
1230	18	82	3.0	90%
1300	15	85	3.0	90%
1400	13	88	3.0	90%

As the 1 hour fuel moistures dropped to 5.0% and Probability of Ignition increased to 60%, the duff/litter began to flame. In some cases intensities were high enough to cause conifers to torch out and send burning embers across control lines. One of these embers may have started the spot fire on the southwest corner of the fire that is identified as SEQUENCE II.

The SEQUENCE II fire run started near the bottom of a small hill and ran up the slope on the south/southwest flank of the Sequence I fire. It reburned through a portion of the Sequence I fire on the ridgetop and then continued uphill. As the Sequence II fire ran uphill on a near 0 degree vector, the slopes became steeper (up to 100%+). Estimated fire behavior at 1300 hours was:

FUEL MODEL	SLOPE	RATE OF SPREAD	ADJ. ROS	FIRELINE INTENSITY	FLAME LENGTH
4	40%	262 CHAINS/HR	131 C/HR	14202BTU/FT/SEC	36.6 FEET
4	80%	239 CHAINS/HR	119 C/HR	17885BTU/FT/SEC	40.7 FEET
6	40%	119 CHAINS/HR	59 C/HR	1210BTU/FT/SEC	11.8 FEET
6	80%	151 CHAINS/HR	75 C/HR	1528BTU/FT/SEC	13.1 FEET

NOTE: All fire behavior predictions are from BEHAVE prediction system . The rate of spread (ROS) was not constant due to the many cliffs and rock outcrops encountered by the running crown fires. The predicted ROS is reduced 50% to allow for this.

As Sequence II continued uphill, a slight wind shift occurred along the north/northeast flank, allowing SEQUENCE III to begin. Vectoring of this run ranged from 290 degrees to 360 degrees with an average of 315 degrees. Slopes ranged from 20-30% near Sequence I to 80-100% farther up the slope. As Sequence III moved on to steeper slopes, the slope overrode the wind and the vector was within +/- 10 degrees of 0 degrees vector. As with Sequence II, cliffs and rocks slowed the fire spread to 50% of predicted. The following is the estimated fire behavior at 1400 hours with a vector of 325 degrees::

FUEL MODEL	SLOPE	RATE OF SPREAD	ADJ. ROS	FIRELINE INTENSITY	FLAME LENGTH
4	20%	313 CHAINS/HR	157 C/HR	17041BTU/FT/SEC	39.8 FEET
4	80%	386 CHAINS/HR	193 C/HR	21019BTU/FT/SEC	43.8 FEET
6	20%	141 CHAINS/HR	70 C/HR	1436BTU/FT/SEC	12.7 FEET
6	80%	175 CHAINS/HR	88 C/HR	1781BTU/FT/SEC	14.1 FEET

The exact origin of SEQUENCE IV is unknown, could have been from spotting, rolling debris, or just from a backing fire that originated from either Sequence I or III. It did get established and as soon as this fire reached the north/northeast side of the small drainages below Sequence I, the wind, slope, and aspect were favorable for a 0 degree vector run up a small drainage towards the north and the original morning helispot. As Sequence IV progressed north, it pulled the west flank of Sequence III cross-slope. As Sequences III and IV met, extreme fire behavior developed with very high intensities. This helped keep the Sequence IV heat to the right side (east side) of the drainage which kept the three firefighters from getting hit with life-threating fireline intensities. As the Sequence IV run overran the helispot, it eddied into the drainage and then vectored to the southeast up a drainage away from the three firefighters. This Sequence IV run missed the three firefighters on the rock ledge by an estimated 50 to 150 feet. The following is the estimated fire behavior at 1500 for Sequence IV at a 0 degree vector:

FUEL MODEL	SLOPE	RATE OF SPREAD	ADJ. ROS	FIRELINE INTENSITY	FLAME LENGTH
4	20	245 CHAINS/HR	171 C/HR	13,337 BTU/FT/SEC	35.6 FEET
4	40	260 CHAINS/HR	182 C/HR	14,306 BTU/FT/SEC	36.7 FEET

Note: The ROS was reduced 30% for rock and openings.

As the Sequence IV run lost the heat pull from Sequence III, the left side or west flank of Sequence IV began short head fire runs up a 15-20% slope. This is known as SEQUENCE V. The vectors for these runs probably were not consistent and ranged from 0 degrees to 60 degrees. Fortunately for the three firefighters, the remaining unburnt areas within Sequence V consisted of mainly Fire Behavior Fuel Model 6 areas, which burned at a much less intense rate than Fuel Model 4, but still at a fire intensity rate that, without protection, would be life-threating. The following is the estimated fire behavior at 1500 for Sequence V with a 20% slope and 3 different vectors:

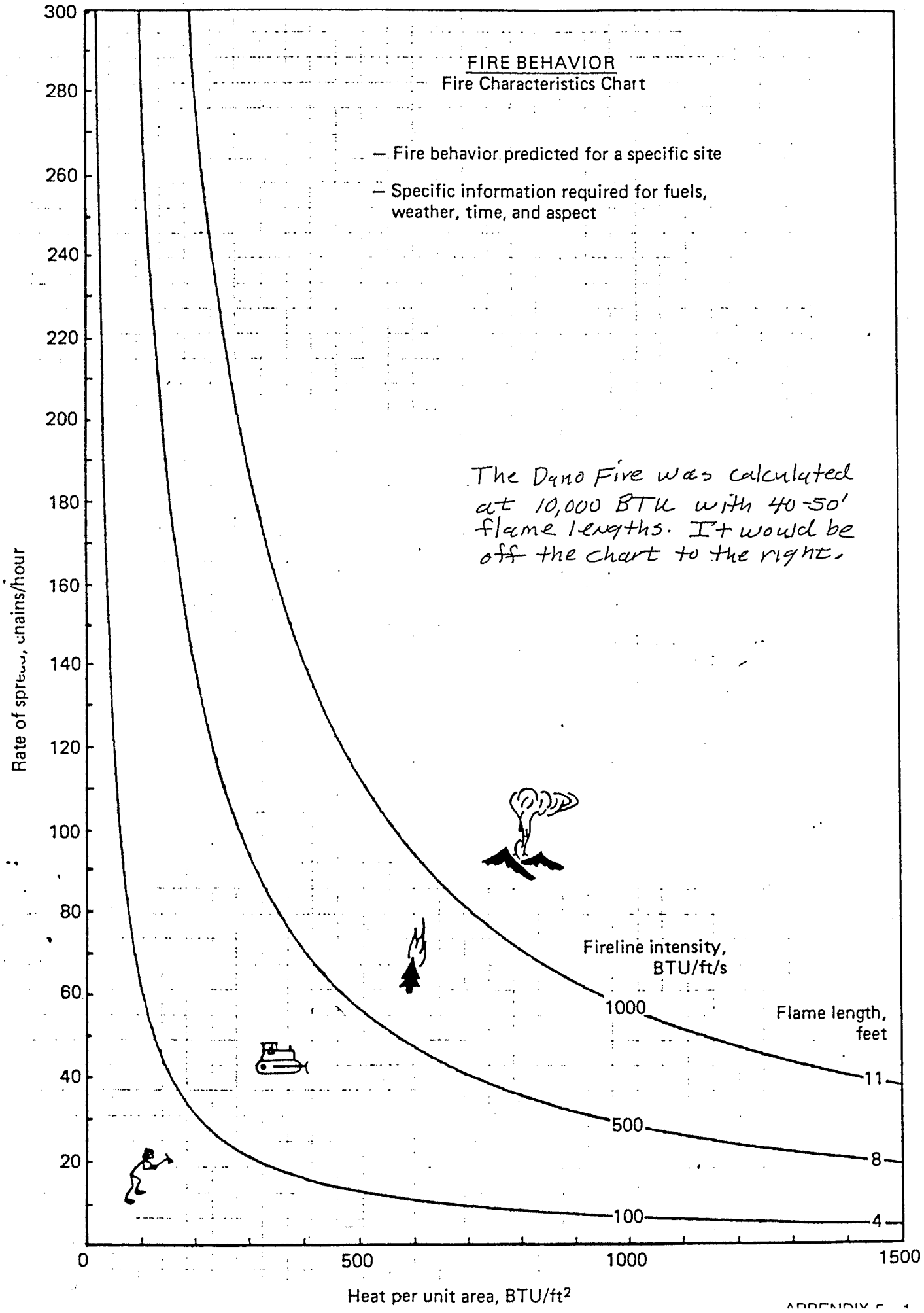
FUEL MODEL	VECTOR	RATE OF SPREAD	ADV. ROS	FIRELINE INTENSITY	FLAME LENGTH
6	0	112 CHAINS/HR	56 C/HR	1,148 BTU/FT/SEC	11.5 FEET
6	30	112 CHAINS/HR	56 C/HR	1,144 BTU/FT/SEC	11.5 FEET
6	60	111 CHAINS/HR	55 C/HR	1,134 BTU/FT/SEC	11.4 FEET

The different vectors in Sequence V had little effect on the fire intensity. The ROS was reduced 50% for rock and small openings.

Spotting from head fires and flank fires was a significant aspect of the overall fire spread and intensity. As a head fire was running up a particular slope, spots occurred both ahead of and on the flanks of the run. This spots became head fires as the fire spotted above rock cliffs and continued upslope and cross-slope. Fortunately, most spotting occurred away from firefighters but it is important to note what the spotting distances were at the time of the major runs. The following is the estimated spotting distances for the different Sequences:

SEQUENCE	20' WIND	# TREES	SPOT DISTANCE (MILES)	SPOT DISTANCE (FEET)
I	3	2	.11	570
II	15	30+	.65	3,432
III	25	30+	1.23	6,494
IV	30	30+	1.49	7,867
V	15	5	.48	2,534

APPENDIX 5
HAULING CHART


FIRE BEHAVIOR
Fire Characteristics Chart
— Fire behavior predicted for a specific site
— Specific information required for fuels, weather, time, and aspect
The Dano Fire was calculated at 10,000 BTU with 40-50' flame lengths. It would be off the chart to the right.
Rate of spread, chains/hour
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
500
1000
1500
Heat per unit area, BTU/ft²
Fireline intensity, BTU/ft/s
1000
500
100
Flame length, feet
11
8
4

FIRE SEVERITY RELATED TO FUEL MOISTURE CHART

R.H. (%)	1-Hr. F.M. %	10-Hr. F.M. %	Relative ease of chance ignition and spotting, general burning conditions
>60	>20	>15	Very little ignition; some spotting may occur with winds above 9 mi/h.
45-60	15-19	12-15	Low ignition hazard - campfires become dangerous; glowing brands cause ignition when relative humidity is <50 percent.
30-45	11-14	10-12	Medium ignitability - matches become dangerous; "easy" burning conditions.
26-40	8-10	8-9	High ignition hazard - matches always dangerous; occasional crowning, spotting caused by gusty winds; "moderate" burning conditions.
15-30	5-7	5-7	Quick ignition, rapid buildup, extensive crowning; any increase in wind causes increased spotting, crowning, loss of control; fire moves up bark of trees igniting aerial fuels; long distance spotting in pine stands; dangerous burning conditions.
<15	<5	<5	All sources of ignition dangerous; aggressive burning, spot fires occur often and spread rapidly, extreme fire behavior probable; critical burning conditions.

March 1983

APPENDIX 6
INTERAGENCY SAFETY ALERT

*****SAFETY ALERT*****
DANO FIRE SHELTER DEPLOYMENT
SHOSHONE NF - 8/27/96

-- Insure that critical fire behavior indicators such as live and dead fuel moistures are provided to fireline personnel and are used in size ups!

-- Be aware of poor night time fuel moisture recovery and rapid drying of fine fuels in the late morning and afternoon!

-- Watchout for erratic winds and fire behavior in canyon environments! Canyon environments continue to demonstrate down canyon and down slope winds!

-- Its 1300 on your fire! Do you know where your escape routes are and if you can reach them before a fire run!

-- Make sure escape routes are "really" adequate! Have escape routes been timed, scouted, marked, positioned away from the fire head, and are walkable?

-- Fireline personnel need to speak up and take action when feeling uncomfortable with tactics or strategies that are being employed!

Provided By:
Dano Fire Shelter Deployment Review Team

Glossary

Aerial Fuels: All live and dead vegetation in the forest canopy or above surface fuels, including tree branches and crowns, snags, moss, and high brush.

Air Tanker: A fixed-wing aircraft equipped to drop fire retardants or suppressants.

Anchor Point: An advantageous location, usually a barrier to fire spread, from which to start building a fireline. An anchor point is used to reduce the chance of firefighters being flanked by fire.

Aspect: Direction toward which a slope faces.

Backing Fire: Fire spreading against the wind or downslope. A fire spreading on level ground without wind is a backing fire.

Behave: A system of interactive computer programs for modeling fuel and fire behavior. BEHAVE consists of two systems: BURN and FUEL.

Blowup: A sudden increase in fire intensity or rate of spread strong enough to prevent direct control or to upset control plans. Blowups are often accompanied by violent convection and may have other characteristics of a fire storm. See FLAREUP.

Bucket Drops: The dropping of fire retardants or suppressants from specially designed buckets carried by helicopter like sling loads.

Burning Index: A relative number related to the contribution that fire behavior makes to the amount of effort needed to contain a fire in a specified fuel type. Doubling the burning index indicates that twice the effort will be required to contain a fire in that fuel type as was previously required, providing all other parameters are held constant.

Burning Out: A type of suppression fire used to widen control lines during line construction or to eliminate unburned fuels inside the control lines after containment.

Cold Front: The leading edge of a relatively cold air mass that displaces warmer air. The heavier cold air may cause some of the warm air to be lifted. If the lifted air contains enough moisture, the result may be cloudiness, precipitation, and thunderstorms. If both air masses are dry, no clouds may form. Following the passage of a cold front in the Northern Hemisphere, westerly or northwesterly winds of 15 to 30 or more miles per hour often continue for 12 to 24 hours.

Contain (Confine) A Fire: To take fire suppression action as needed, which can reasonably be expected to keep the fire within established boundaries under prevailing conditions.

Control A Fire: To complete a control line around a fire, any spot fires therefrom, and any interior islands to be saved; burn out any unburned area next to the fire side of the control lines; and cool down all hotspots that immediately threaten the control line until the lines can reasonably be expected to hold under foreseeable conditions.

Control Line: All built or natural fire barriers and treated fire edge used to control a fire.

Crew: An organized group of firefighters under the leadership of a crew leader or other designated official.

Crowning: The movement of fire through the crowns of trees or shrubs more or less independently of the surface fire.

Deployment: See FIRE SHELTER DEPLOYMENT.

Direct Attack: Any treatment of burning fuel, such as by wetting, smothering, or chemically quenching the fire or by physically separating burning from unburned fuel.

Dispatch Center: A facility from which resources are directly assigned to an incident.

Dead Fuels: Fuels with no living tissue in which moisture content is governed almost entirely by atmospheric moisture (relative humidity and precipitation, dry-bulb temperature, and solar radiation).

Energy Release Component (ERC): The computed total heat released per unit area (British thermal units per square foot) within the fire front at the head of a moving fire.

Engine Crew: Firefighters assigned to an engine. The Fireline Handbook defines the minimum crew makeup by engine type.

Entrapment: A situation in which a fire traps people in a life-threatening position with no, inadequate, or compromised evacuation routes or safety zones. An entrapment may or may not involve deploying fire shelters.

Extreme Fire Behavior: A level of fire behavior that ordinarily precludes methods of direct control.

Fire Behavior: How a fire reacts to the variables of fuel, weather, and topography.

Fire Behavior Specialist: A person responsible to the Planning Section Chief for establishing a weather data collection system and for developing fire behavior predictions based on fire history, fuel, weather, and topography.

Firefighting Resources: All people and major items of equipment that can or potentially could be be assigned to fires.

Fire Front: The part of a fire within which continuous flaming combustion is taking place. Unless otherwise specified, the fire front is assumed to be the leading edge of the fire perimeter. In ground fires, the fire front may be mainly smoldering combustion.

Fire Intensity: A general term relating to the heat energy released by a fire.

Fireline: A linear fire barrier that is scraped or dug to mineral soil.

Fire Load: The number and size of fires historically experienced on a specified unit over a specified period (usually 1 day) at a specified index of fire danger.

Fire Perimeter: The entire outer edge or boundary of a fire.

Fire Shelter: A personal protection item carried by fire fighters that, when deployed, unfolds to form a ten-like shelter of heat reflective materials.

Fire Shelter Deployment: The removing of a fire shelter from its case and using it properly for protection against fire.

Fire Weather: Weather conditions that influence fire ignition, behavior, and suppression.

Flame Depth: The depth of the fire front.

Flame Front: See FIRE FRONT.

Flame Length: The distance between the flame tip and the midpoint of the flame depth at the base of the flame (generally the ground surface), an indicator of fire intensity.

Flareup: Any sudden acceleration of fire spread or intensification of a fire. Unlike a blowup, a flareup lasts a relatively short time and does not radically change control plans. See BLOWUP.

Fuel Moisture (Fuel Moisture Content): Water content of a fuel expressed as a percentage of its ovendry weight.

Fuel Size:	1 hour	0 to 1/4 inch
	10 hour	1/4 to 1 inch
	100 hour	1 inch to 3 inch
	1000 hour	3 inch to 9 inch
	10000 hour	9 inch +

Fuel Type: An identifiable association of fuel elements of distinctive plant species, form, size, arrangement, or other characteristics that will cause a predictable rate of fire spread or difficulty of control under specified weather conditions.

Ground Fuel: All combustible materials below the surface litter (duff, tree roots, punky wood, organic soil, sawdust) that normally support glowing combustion without flame.

Handline: A fireline built with hand tools.

Head Of A Fire: The side of the fire having the fastest rate of spread.

Helibase: The main location within the general incident area for parking, fueling, maintaining, and loading helicopters. The helibase is usually located at or near the incident base.

Helispot: A temporary landing spot for helicopters.

Helitack Crew: A group of firefighters trained in the technical and logistical use of helicopters for fire suppression.

Hotspot: A particularly active part of a fire.

Hotspotting: Reducing or stopping the spread of fire at points of particularly rapid rate of spread or special threat, generally the first step in prompt control, with emphasis on first priorities.

Incident: A human-caused or natural occurrence, such as a wildfire, that requires emergency service action to prevent or reduce the loss of life or damage to property or natural resources.

Incident Commander (IC): The person responsible for managing all incident operations.

Initial Attack (Action): The first suppression action on a fire.

Lead Plane: Aircraft with pilot used to make dry runs over the target area to check wind and smoke conditions and topography and to lead air tankers to targets and supervise their drops.

Light (Fine) Fuels: Fast-drying fuels, generally with a comparatively high surface area-to-volume ratio, which are less than 1/4 inch in diameter and have a timelag of 1 hour or less. These fuels readily ignite and are rapidly consumed by fire when dry.

Line Scout: A firefighter who determines the location of a fireline.

National Fire Danger Rating System (NFDRS): A multiple index scheme designed to give fire suppression people and land managers a systematic means of assessing aspects of fire danger on a day-to-day basis.

National Fire Management Analysis System (NFMAS): Analysis of costs for fire suppression versus resource net value change.

Nomex: The generic name for a high-strength, flame-resistant, synthetic fabric used in the shirts and jeans of firefighters. Nomex, a brand name fro aramid fabric, is the term commonly used by firefighters.

Overhead: People assigned supervisory positions, including incident commanders, command staff, general staff, directors, supervisors, and unit leaders.

Perimeter: See FIRE PERIMETER.

Rate Of Spread: The relative activity of a fire in extending its horizontal dimensions, expressed as the rate of increase of the perimeter, rate of increase in area, or rate of advance of its head, depending on the intended use of the information. Rate of spread is generally expressed in chains or acres per hour for a specific period in the fire's history.

RAWS: See REMOTE AUTOMATIC WEATHER STATION.

Relative Humidity (Rh): Percentage of the actual vapor pressure of the air to the saturation vapor pressure; the ratio, expressed as a percentage, of the amount of water vapor in the air compared to the amount the air can hold under the same conditions.

Remote Automatic Weather Station (RAWS): An apparatus that automatically acquires, processes, and stores local weather data for later transmission to the GOES Satellite, from which the data is retransmitted to an earth receiving station for use in the National Fire Danger Rating System.

Reburn: The burning of an area that has been previously burned but that contains flammable fuel that ignites when burning conditions are more favorable; an area that has reburned.

Red Flag Watch: A term used by fire weather forecasters to notify using agencies, usually 24 to 72 hours ahead of the event, that current and developing meteorological conditions may evolve into dangerous fire weather.

Resource Order: An order placed for firefighting resources.

Resources: See FIREFIGHTING RESOURCES.

Retardant: A chemical having a retarding action on fire.

Run (Of A Fire): The rapid advance of the head of a fire with a marked change in fireline intensity and rate of spread from that noted before and after the advance.

Safety Zone (Area Or Island): An area used for escape should the fireline be outflanked or a spot fire fuels outside the fireline to make the fireline unsafe.

Scratchline: An unfinished preliminary fireline hastily established or built as an emergency measure to check the spread of fire.

Sizeup (Or To Size Up): The evaluation of (or to evaluate) a fire to determine a course of action for fire suppression.

Slopover (Breakover): A fire edge that crosses a control line or the resultant fire.

Spot Fire: Fire set outside the perimeter of the main fire by flying sparks or embers.

Spotter: In smokejumping, the person responsible for selecting drop targets and supervising all aspects of dropping smokejumpers.

Spotting: Behavior of a fire producing sparks or embers that are carried by the wind and start new fires beyond the zone of direct ignition by the main fire.

Spot Weather Forecast: A special forecast issued to fit the time, topography, and weather of each specific fire. These forecasts are issued upon request of the user agency and are more detailed, timely and specific than zone forecasts.

Strategy: The science and art of command as applied to the overall planning and conduct of an incident.

Suppressant: An agent, such as water or foam, used to extinguish the flaming and glowing phases of combustion when directly applied to burning fuels.

Suppression: All the work of extinguishing or confining a fire, beginning with its discovery.

Surface Fuels: Loose surface litter on the soil surface, normally consisting of fallen leaves or needles, twigs, bark, cones, and small branches that have not yet decayed enough to lose their identity; also grasses, forbs, low and medium shrubs, tree seedlings, heavier branchwood, downed logs, and stumps interspersed with or partially replacing the litter.

Tactics: Deploying and directing resources on an incident to meet objectives determined by strategy.

Timelag: Time needed under specified conditions for a fuel particle to lose about 63 percent of the difference between its initial moisture content and its equilibrium moisture content. If conditions remain unchanged, a fuel will reach 95 percent of its equilibrium moisture content after 4 timelag periods.

Torching: The ignition and later flareup of a tree or small group of trees, usually from bottom to top.

Type: The capability of a firefighting resource in comparison to another type. Type I usually means a greater capability due to power, size, or capacity.

Underburn: A fire that consumes surface fuels but not trees or shrubs. See SURFACE FUELS.

Vectors: Directions of fire spread as related to rate of spread calculations (in degrees from upslope).

Wildland Fire (Wildfire): Any fire occurring on land that is essentially undeveloped except for roads, railroads, powerlines and similar transportation facilities.

Wind Vectors: Wind directions used to calculate fire behavior.