PRELIMINARY REPORT
OF
TASK FORCE

on study of

FATAL/NEAR-FATAL WILDLAND FIRE ACCIDENTS

April 1980

TABLE OF CONTENTS:

EXECUTIVE SUMMARY*

1. Further reductions in the number of fire-related fatalities and near-misses are achievable. (Problem Identification)

2. Part of the continuing fire-accident problem appears to be incomplete implementation of previous studies' recommendations. (Introduction)

3. Positive in-depth followup and implementation of this study's recommended solutions should be spearheaded by NWCG. (Introduction)

4. No wildland fire situation, with the possible exception of threat to human survival, requires the exposure of firefighters to life-threatening situations. All firefighting agencies need to adopt this premise as a clear fire safety policy. (Problem Identification)

5. The two groups most susceptible to serious injury or death are the inexperienced people and those with 10-15 years experience. (Qualifications)

6. There is evidence to indicate that carbon monoxide exposure experienced by wildland firefighters can cause irrational behavior and impair judgment. Existing information on this subject needs to be more widely distributed and emphasized. Further research should pay off well. (Carbon Monoxide and Impaired Judgment)

7. Prescribed fires are emerging as a major fire safety problem. (Prescribed fires - Major Problem?)

8. Rewards to those who do good, safe fire work should be increased. (Accountability)

9. A "professional" image needs to be emphasized for firefighters--rather than the "rough-and-tumble" image which is sometimes consciously and sometimes subtly emphasized. The "professional image should integrate proper safety practices. (Human Behavior; An Inspection of Erratic Fire Behavior; Accountability)

10. A problem exists with regard to inadequate accountability for wildland fire safety. Followup is needed to assure correction of identified safety problems. (Accountability)

11. A "double standard" exists between organizations using NIFQS or equivalent qualifications systems--and RFD's, ranchers, or other locals working on the same fire. Frequently the locals meet only minimal, if any, qualifications requirements. The disparity in qualifications presents serious questions from the standpoint of safety. (Qualifications)

*Report subject-areas, from which summary statements were taken, are noted in parentheses. Background discussion can be found by referring to the corresponding subject-area.

12. Firefighting personnel need to be trained for handling panic. They should automatically use proper survival techniques. (Human Behavior)

13. Survival techniques, using the capabilities commonly found on fire equipment, need to be more fully developed. Widespread information distribution and training should follow. (Survival Techniques -- RE: Fire Equipment)

14. The interaction of aircraft wake turbulence and helicopter vortices with fire behavior is not well-enough understood throughout the fire community. Both air and ground personnel need to appreciate better the effects of aircraft on fire behavior. (Aircraft Effects on Fire Behavior)

15. Interpersonal communication feedback-drills are needed for fire personnel. They are needed to give practice in establishing a clear understanding between the sender and the receiver. (Human Behavior)

16. Complete and regular briefings of all firefighting personnel should continue to receive emphasis. (Human Behavior)

17. Shift overlaps, or other means to assure the briefing of overhead personnel coming on shift by those going off shift, should continue to receive emphasis. (Human Behavior)

18. There is a problem with the accurate prediction of fire behavior. The problem is frequently confused under the guise of "erratic fire behavior." Predictive capabilities need to be improved. (An Inspection of Erratic Fire Behavior)

19. Fire safety training should include the case-study method based on lessons learned from past tragedies. Training presentations should be adapted to the local areas. (Two Approaches -- State & Federal -- To a Fire Safety Turnaround)

20. In principle, the Ten Standard Firefighting Orders and the Thirteen Situations That Shout "Watch Out" are still valid. However, they need to be made easier to remember; and memorization should be emphasized. Instead of the "Ten" and the "Thirteen", the following Eight Fire Fighting Commandments are proposed: (Fire Safety Training)

W - WEATHER - dominates fire behavior so keep informed.
A - ACTIONS - must be based on current and expected fire behavior.
T - TRY OUT - at least two safe escape routes.
C - COMMUNICATIONS - maintain them with your crew, your boss, and adjoining forces.
H - HAZARDS - to watch for are flashy fuels, steep slopes, and chimneys.

O - OBSERVE - changes in wind direction or velocity, humidity, clouds.
U - UNDERSTAND - your instruction and make sure your are understood.
T - THINK - clearly, be alert, and act decisively before your situation becomes critical.

21. The fire accident reporting system needs to be steered toward discovering all cause-effect relationships from which practical corrective actions can be derived. That will enable managers to determine how responsibilities may be clarified and supported so that errors are reduced. (Available Information)

22. The existing accident reporting systems need to be developed so that objective evaluation can be made of fatal-near-fatal fire incidents. (Objective Data Base)

    An existing method of national fire information distribution should be used to promptly circulate brief recaps of fatal/near-fatal fire accidents and incidents. Key points that are important in preventing similar occurrences should be given. (Two Approaches -- State & Federal -- To a Fire Safety Turnaround)

INTRODUCTION

NWCG CHARTERED STUDY:

During 1979 there were 15 fire-related deaths and a number of near misses experienced by Federal, State, and Canadian fire-fighting agencies. This is an increase in the trend over the last several years.

The National Wildfire Coordination Group (NWCG) established an ad hoc task force to analyze the problem, identify any common causes, and make recommendations to reduce the occurrence of this type of accident. This is the task force's report.

Guidelines Given Task Force:

The task force was told to consider:

- Fire related fatal and near-fatal accidents and incidents, excluding aircraft mishaps and minor occurrences. Both wildfire and prescribed fire occurrences were to be considered.

- Problems experienced in 1979 as well as in previous years.

- Developing recommendations that are within the ability of the agencies to respond, not just bandaids or additional workloads.

Additional guidelines were:

- Access pertinent accident reports and other sources of information.

- Analyze the reports and prepare recommendations.

- Minimize travel by conducting much of the review and final writeup at the home offices.

- Submit the task force report to the NWCG at the May 1980 meeting.

Task Force Membership: (Addresses and telephone numbers of the task force members are given for the convenience of the reader who may wish to discuss particular areas with the subject leaders as identified further on in this introduction.)

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Assumptions Made by Task Force:

- The perception that there is a problem is generally held throughout the fire community.

- An open and honest appraisal was sought and that no area of inquiry would be considered "off limits."

- The time available would allow the task force to identify solutions having promise of substantial benefit; and that positive in-depth followup and implementation of solutions would be initiated by NWCG in acting on task force recommendations contained in this report.

Method of Study:

The task force was officially established early in 1980. Reports and information on fatal and near-fatal wildfire and prescribed fire related accidents and incidents were sought from throughout the U.S. and Canadian fire communities. Early in February the task force met in Boise, Idaho to review the information collected and structure the study

Study began with consideration of the following "Discussion Starters" which had been provided to the task force by the BLM Division of Fire and Aviation Management, in Washington:

- We expect and deal with erratic fire behavior.

- Guard School Training - old timer supervision - lacking today.

- Dependence on safety equipment vs. training and experience.

- Carl Wilson Report; conclusions good.

- Need supervision by sector boss - division boss to pull people out of bad situations.

- Selection vs. training.

- Problems occurred on small fires in 1979.

- Initial attack training lacking in NIFQS.

- Accident Records & Injury Rates.

- You have to expect, and accept, some accidents.

- Present rules (10 std. orders, etc.) OK, but not followed.

- Trained, but is she or he qualified?..

- Has skills, knowledge, and abilities; but got into trouble and didn't use them.

- What is lacking?

- Is turnover of experienced people a problem?

- Is NIFQS training enough?

- Effect of management pressures - do more with less.

- Super dedicated suppression personnel - not staying aware of fire environment they are in.

- There is a psychology of individuals not acknowledging personal peril.

Study subject areas were assigned to task force members as follows:

- Analysis of Accidents to Identify Key Facts . . . Carl Wilson
- Problem Identification . . . . . Art Belcher
- Available Information . . . . . Jim Stevens
- Objective Data Base . . . . . Art Belcher
- Qualifications . . . . . Dave Dahl
- Human Behavior . . . . . Arlan Smith
- An Inspection of Erratic Fire Behavior . . . . . Jim Cumming
- Aircraft Effects on Fire Behavior . . . . . Jim Cumming
- Prescribed Fires - Major Problem? . . . . . Dave Dahl
- Fire Safety Training . . . . . Carl Wilson
- Survival Techniques . . . . . Jim Cumming
- S-480 Draft Review . . . . . Art Belcher
- Two Approaches (State & Federal) To A Fire Saftey Turnaround . . . . . Carl Wilson
- Carbon Monoxide & Impaired Judgement . . . . . Art Belcher
- Equipment . . . . . Dave Dahl
- High Risk Conditions . . . . . Jim Stevens
- Accountability . . . . . Arlan Smith

Each subject leader investigated and reported on his assigned area. The individual reports were then consolidated into this final task force report.

Relationship to Previous Studies:

Numerous fire safety studies, reports, and analyses dating back to the mid-1950's were reviewed during the course of this study. IT IS SIGNIFICANT TO NOTE THAT MANY OF THE SAME ISSUES THAT EMERGED FROM THIS STUDY WERE ALSO FOUND REPEATEDLY IN THOSE PREVIOUS INVESTIGATIONS. Part of the problem, then, appears to be incomplete implementation of previous study recommendations.

Acknowledgement:

The task force members wish to acknowledge the excellent cooperation given by many individuals throughout the fire community. Very thoughtful analyses, reports and information, suggestions, and constructive comments were shared - and the members of this task force greatly appreciate the extra time and effort willingly put forth by those who demonstrated their deep concern by their excellent participation.

PROBLEM IDENTIFICATION

Issue:

There is a feeling among all agencies that the number of, and potential for, fatal accidents is increasing. However, it is not possible to compile adequate evidence to examine this conclusion. Similarly, near-miss situations are felt to be occurring with a greater frequency.

Discussion:

There were 15 lives lost during 1979 which were associated with wildland firefighting activities. There were numerous near-misses, some of which were informally reported and many more which were ignored. The task force is not sure that all the fatalities were reported during the investigation.

It is apparent from the review of past fatal and non-fatal incidents that there is substantial risk-taking which is not commensurate with the values threatended. In no incident were non-firefighter lives immediately threatened, and in almost every incident the fire was controlled shortly thereafter or the sector involved was secured. There is no justification for risking firefighter lives in a wildland situation dealing with renewable resources. Firefighting is a paramilitary operation. However, the parallel stops at the point where casualties are acceptable to the action strategy.

Recommendation:

1. All firefighting agencies adopt, as wildland fire safety policy, the premise that no wildland fire situation - with the possible exception of threats to human survival - requires the exposure of firefighters to life-threatening conditions and situations.

2. Improve data gathering - as described under the Objective Data, and Available Information sections of this report.

AVAILABLE INFORMATION:

Issue:

Purpose of Preparing Reports; Uniformity, Quality and Availability of Reports; Objectives of Fire Reviews.

Discussion:

The following is a quote from the U.S. Energy Research and Development Administration's (ERDA) Accident/Incident Investigation Manual:

> "The primary purpose of an accident investigation is to prevent similar occurrences and thus improve the safety of ERDA operations. The emphasis should be on discovering all cause-effect relationships from which practical corrective remedial actions can be derived. The intent is not to place blame, for all people err, but to determine how responsibilities may be clarified and supported and errors reduced...."
>
> "The purposes do not include: enforcement proceedings, liability determination, or controlled research - all of which require supplementary or separate investigations."

This is the very basic premise for all accident investigations. Using this philosophy, ERDA has been successful in uncovering facets of accidents which may never have come to light where a different philosophy on the purpose and use of accident reports was employed by management.

Reviewing the fire-related fatal and near fatal accident reports compiled for this study, one gets a different impression of the purpose for which these investigations were conducted, and of the uses for which these reports were intended. Purposes other than accident prevention seem to influence the information gathering process and the finished report. Some of these collateral purposes appear to be:

a. Line of duty determinations for injured or killed persons

b. Protection of employee or survivor benefits

c. Protection of government interests - from a claims standpoint

d. Determination of private party liability

e. Law enforcement aspects of man-caused fires

f. Justification of: management's fire suppression policies, actions on particular fires, and money spent on suppression

To a greater or lesser degree, depending on circumstances, all of the above seem to be considerations when an accident investigation is conducted. Can fire management realistically expect frank and open discussion of the accident circumstances, e.g. management failure, employee error, etc., when the collateral uses of this information are known to witnesses, investigators, and management? Does the influence of these other purposes have a sanitizing effect on the report?

Information in current reports is restricted in two ways:

a. Shading of the information gathered - Personnel providing statements and/or eyewitness accounts are aware of the many uses to which their information may be put. Concerns such as the protection of a fellow employee, etc., may tend to reduce the accuracy of the information provided. Even if such concerns are not valid, this perception will restrict the information flow.

b. Limited information contained in the final report - Legal implications, agency "black eyes," public scrutiny, etc., are all considered during the finalization of a report. Although the facts usually remain intact, they must be worded very carefully and sometimes meanings are lost. More importantly, the feelings and perceptions of experienced personnel who were present during the accident that might add valuable insight and "gut" feelings to the investigation report are almost always excluded.

Both these possibilities limit the factual information available to different levels of an organization and to other agencies. Personnel of the same organization and the same level at which the accident happened may know the "real story," or somebody's confidential files may hold the answers. But, this information is not available to the people who need it to do valid accident prevention work. To be useful for analysis and prevention, the accident report must be viewed by all concerned, including top management, as a tool to be used solely for accident prevention purposes - and not as a basis for other actions. Until then, our reports and corrective actions based on them are suspect.

For comparison, contrast a "near miss" report to the report of a fatality. With no loss of life or major property damage, the influence of collateral investigation purposes on the final report is much less. Witnesses are normally more willing to be open and frank, management does not feel paranoid about releasing all pertinent information, and a much more accurate and useful report results.

There is no uniformity in report preparation, or, more importantly, in the information reported. Reports vary according to the reporting agency's slant on the purpose for preparation of the report (influence of collateral purposes), and the investigator's experience and background. Many reports indicated the investigators, especially Federal personnel, were unsure what was important so they reported everything.

Although this appears insignificant at first, it results in time wasted gathering unimportant (from a prevention standpoint) information, and a very bulky report with the desired information buried in its depths. Or, even worse, without guidelines, insufficient information is reported. Both of these situations result in poor quality reports and a potential loss of valuable information.

This study has revealed that the reports and information necessary to conduct in-depth analyses of all fire-related fatalities and near-fatals is not readily available. Except for Carl Wilson's excellent work, the reports used to prepare this paper were gathered on a hit or miss basis. Without a doubt, there is more fatality and near miss data than the task force was able to accumulate. Most certainly there are many more near misses that have never been documented. The reports the task force was able to gather were of limited use to some of the study areas due to poor quality and lack of uniformity.

The following is an attempt to convey an objective evaluation of what fire reviews consist of, what they accomplish, and how they could be more effective in preventing fire-related fatalities.

The fire analyses that the task force reviewed spent surprisingly little verbage dealing with the details of the fire and how it was managed/ suppressed. Much of the reports dealt with administrative items and the acquisition of resources. Discussions and subsequent recommendations centered around such things as:

Billing private parties for suppression costs

Theft of government property

Types of meals served in fire camp

Pre-season sign-up of rental equipment

Recruitment of seasonal fire personnel

Pre-fire dispatch plans

Cooperation among Federal and State agencies

All of these are important. The recommendations that are implemented concerning them certainly improve the broad spectrum of fire management activities.

What seems to be missing, or at least not pursued in detail, are the nuts and bolts of how and why the fire was managed as it was. Important questions seem to go unanswered, such as:

a. What were the dangers to life and property during the fire?

b. What were the suppression/management options?

c. What actions were employed and why?

d. Did the chosen actions turn out advantageously from the standpoint of:

(1) Protection of life and property

(2) Safety of fire personnel

(3) Cost effectiveness

Recommendations:

1. An attempt should be made to limit the use of accident reports to accident prevention purposes only. If successful, this should be widely publicized and documented in agency directives.

2. A brief (one page), standard, fire fatality and near miss report form should be developed and used by all concerned agencies. These forms would report the same items of information for every fire-related incident, thereby improving the information available for analysis. Its completion would also provide an orderly approach to the investigation. These standard reports would be sent directly from the unit concerned to a central report registry for compilation. Existing reports would be analyzed and put into this brief format. These would also be entered into this central registry. Items which could be included on such a report are: types of equipment involved, mechanical failures, age and specific training of the injured party, etc. These reports should be protected from public dissemination and not become part of any other agency report. They should not be used for any purpose other than accident prevention. These reports, or analyses of them, would be available to participating units, possibly with the identifying names, etc., removed to insure anonymity.

3. Where a fire fatality or near miss has occurred, an analysis in the fire review of the risk to life or property versus the risk to fire personnel because of the suppression/management actions used seems essential. Answers to these types of questions would give the best perspective on how to manage future fires from all aspects including safety.

OBJECTIVE DATA BASE

Issue:

There is no way within the present accident reporting systems to make an objective evaluation of the fatal and near-fatal incidents.

Discussion:

It became apparent early in the task force's deliberations that the area we were asked to investigate could be approached only on a subjective basis because:

1. The Forest Service has a good data base for fire related accidents and can express them in terms of accident frequency rate (AFR) per hours exposed. They cannot, however, pull out the fatalities as a separate item. Their AFR has, by the way, been declining.

2. Interior agencies can pull accidents related to fire-fighting from 1976 on. Prior to 1976, the coding for fire-fighting was not used.

3. It appears that states may or may not be able to furnish the needed information. If they can, it will be on state employees only. They do not generally have the capability to report for the volunteer or other firefighting organizations.

4. The FEMA reporting system does not have capability of pulling out wildland fatalities.

5. An objective evaluation of how well the National Interagency Fire Qualification System (NIFQS) is serving the users' needs in safety is not possible. Are the cooperating agencies getting their money's worth out of the training/qualification effort? There is no way to tell with the present system.

Recommendation:

Develop the existing accident reporting systems to provide the requisite data at state, province, and National levels. Provide for National-level extraction, consolidation, and analysis of the results.

QUALIFICATION

Issue:

Use of Qualification System to Avoid Accidents.

Discussion:

The National Interagency Fire Qualification System (NIFQS) was established to provide a basic project-fire knowledge and skill level, obtained through a combination of training and experience. This system is not used by all States, nor is it required for prescribed fire by any of the agencies.

The NIFQS requires management to evaluate quality of performance as well as amount of experience and training. For example, if an employee can meet the training and experience criteria for Sector Boss, but exhibits poor supervisory skills, that person would not be "red carded" for the position.

Many fire situations develop where people not meeting NIFQS criteria want to help with wildfire suppression. Occasionally this type of help cannot be rejected, such as a local rancher on whose property the fire is burning or local rural volunteer fire departments.

Managers responsible for recommending or approving a "red carded" position for a person must also evaluate the limitations, if any, that need to be imposed. A "red carded" Sector Boss in the SE may not have experience with certain light, flashy fuels found in the SW.

A third factor relating to qualifications is the initial "woods sense" the beginning fire fighter comes with. Historically, fire fighters came from rural areas and had basic knowledge of equipment, shovels, etc.

Currently many fire fighters come from cities and are completely unfamiliar with the use of tools and equipment. No longer can an assumption about basic skill levels be made.

A review of the fatal and near-fatal records indicate two trends. The accident frequency is high, with initial employment of a fire fighter and then tapers off with experience. A second accident frequency increase again occurs with 10-15 years experience.

Several inferences are drawn from this observation. A majority of fire fighters are young people who are seasonal workers attending school or trying to establish careers, thus a high turnover rate. Those that do make a career out of wildland fire fighting reach responsible positions in 10-15 years. This level of success and experience could result in an over confidence level and a lapse in paying attention to details.

Recommendations:

1. Agencies have an exceptional system to work from in determining education and experience levels needed for fire fighting positions. Management cannot mechanically use the system. Supervisors must look at the qualitative criteria as well as the quantitative.

2. Fire managers must realize local people could be involved in suppression activities and not meet minimum qualifications. Every effort should be made by the local fire manager to incorporate local people into the qualification system, for their own safety as well as the safety of the trained people.

3. New fire fighters must be given basic training. Fire managers must make no assumptions as to innate ability of a new fire fighter.

4. Fire managers should be made aware that the two groups most susceptable to serious injury or death are the inexperienced people and those with 10-15 years experience.

HUMAN BEHAVIOR

Issue:

Firefighters still place themselves in unnecessarily perilous situations. Common reasons for this are: failure to acknowledge personal danger; improper reliance on trucks and tractors as places of refuge; unquestioning acceptance that "firefighting is a dangerous business"; and, that same old bugaboo, interpersonal communications.

Discussion:

The "it won't happen to me" syndrome is as prevalent in firefighting as anywhere else. Individuals commonly do not acknowledge peril to themselves, although they would readily recognize danger to others in similar circumstances. Probably one key reason for this is that, for every situation which has a tragic outcome, often there have been many similar situations in which everything came out all right. Accordingly, attitudes have been shaped and habits formed which accept unsafe practices -- because "that's the way it's been done before". People build confidence that certain unsafe acts carry little risk for them personally because they regularly get away with the unsafe behavior. Perhaps one reason these individuals see no risk to themselves, yet they recognize danger to others, is that they have not seen the others get away with unsafe behavior as frequently as they have. For that reason, they may be good at directing others to work safely without them, yet they sometimes jeopardize the entire group when they accompany the others in performing tasks. It has been well established, by Wilson in 1977, that fatal and near-fatal incidents occur in deceptively simple and easy fire situations -just the kind of situation where the "it won't happen to me" syndrome can be expected to be strongest.

The lack of acknowledgement of personal peril, and one other key factor, panic, are manifested in a large number of the fire tragedies studied. An improper reliance on pumper trucks and tractors as places of refuge is one illustration of this. The equipment was used for refuge at times when it should not have been; and it was not used, or not used properly, at times when it really should have been. Survival techniques for pumper and tractor crews are treated in detail further on in this report. The point here is that overconfidence, bad habits, or panic led to improper, unsafe actions. Individuals were not conditioned for the proper response which would have ensured their selection of the best alternatives available.

A similar illustration could be drawn with the use of fire shelters -- this was a matter of grave concern to nearly all of the fire personnel contacted. There is a high potential for bad habits to be developed for the unsafe use of fire shelters, since there are definite limits beyond which either overreliance or underreliance on shelters can needlessly jeopardize lives.

Training, if properly designed and presented, can be effective in conditioning appropriate response patterns into individuals. Experience, on the other hand, tends to reinforce individuals' feelings that they can get away with unsafe performance -- unless peers or supervisors promptly point out the mistake, make it clear that such performance is absolutely not acceptable, and see to it that job behavior changes so that proper work habits are established and reinforced.

Another element that tends to lead firefighters to accept unnecessary peril is the "rugged" image that surrounds fire personnel. Firefighting is a rough-and-tumble business fraught with dangers. There is a school of thought that holds that firefighters must, therefore, be rough-and-tumble people in order to match the job. The image builds, then, of the firefighter as a kind of super-person who can take on the toughest of jobs, work hours on end without fatigue, eat practically anything, and go without sleep -- while simultaneously giving top performance. Along with the "rugged" image is the attitude that minor injuries, and occasionally major danger, are just part of the job. These things are accepted almost without question in a manner similar to the acceptance of battle casualties in wartime -- although the top fire management offices have clearly stated that no fire loss is worth any human loss. The "rugged" image affects all firefighters to at least some degree, and it manifests itself through the acceptance of safety practices that would be unnacceptable in almost any other line of work. Common sense and rational safety procedures are often disregarded, even when they have been taught in training programs, in favor of unnecessary risk taking that is accepted as just being a part of the rough-and-tumble firefighting business.

Communication between individuals fighting the fire is still felt to be a major safety problem. This has been pointed out in past studies, and there has not been much improvement. Supervisors are still concentrating on giving clear and complete orders and expecting those at lower levels to hear, understand, and obey -- without using feedback from the lower levels to be sure their order really got through as intended. Supervisors are presuming much more understanding of the managerial situation by the lower levels than there really is. Good briefings are the exception rather than the rule. Shift changes are plagued with discontinuities in overhead assigned to specific positions; rather than the overlap needed to assure continuation of operations planned and in progress, and sharing of the knowledge of the situation by those who have been there most recently with those who are next in line. Positive confirmation to those giving the orders, from those receiving the orders, that the message was received and understood as intended is, unfortunately not yet always happening. This, also, is felt to be one of the primary reasons firefighters place themselves in unnecessary peril.

Recommendations:

1. Periodically train firefighting personnel for handling panic and automatically using proper survival techniques. The problem of individuals placing themselves in needlessly perilous situations is best solved by preventing it in the first place. However, that is a long-term solution and the means of implementing it would probably be considered as "bandaids" or "just another workload" within the objectives for this study which seeks readily-productive measures that managers can take. Therefore, drills to practice and ingrain into individuals' behavior response patterns the proper actions in the face of a variety of emergencies are recommended. The guidelines for these drills should be developed by BIFC as quickly as possible. The objective would be to present them throughout the fire community, one subject at a time in a manner akin to tailgate safety sessions. Subjects should cover survival drills in such situations as: when a crew is trapped with a pumper truck, when an operator is trapped with a tractor, when personnel are trapped without having located a safety zone in advance, and other instances where panic may override thoughtful use of resources commonly available in entrapment situations. The objective is to enable personnel to respond correctly and involuntarily.

2. Emphasize a "professional" image for firefighters, which integrates proper safety practices into the image, rather than the "rough-and-tumble" image which is sometimes consciously and sometimes subtly emphasized today. (See also Recommendation #1 under Accountability, and Recommendations #3 under An Inspection of Erratic Fire Behavior, in this report. Provide this emphasis as recommended therein.)

3. For the next two years, supplement all fire training course presentations with a 1/2-hour specialized review of the communications process. Emphasis should be on feedback drills to practice establishing a clear understanding of information communicated between the sender and the receiver. BIFC Training should develop the 1/2-hour supplement and circulate it throughout the fire community with instructor preparation guidance. Over a longer period of time, integrate this training more into routine training and refresher experiences.

4. Continue to emphasize complete and regular briefings of all firefighting personnel. This gives lower level personnel the background to understand supervisors' directions within the same context as they are given.

5. Continue to emphasize shift overlaps or other means to firm-up the briefing of overhead personnel coming on shift by those going off shift. This provides continuity of operations, and better identification of safety considerations.

AN INSPECTION OF ERRATIC FIRE BEHAVIOR

Issue:

That erratic fire behavior is the primary cause of fire fatalities and near misses.

Discussion:

An analysis of 125 wildland fires which include 236 fatalities and 66 near miss situations also involving a substantial number of personnel reveals that the tragedies or emergencies were precipitated by the following basic fire behavior characteristics.

1.	Fire Ran Upslope	29.6%
2.	Sudden Wind Shift	20.8%
3.	Head Made Fast Run	13.6%
4.	Fire Spotted Across Line (often followed by uphill run)	9.6%
5.	Fire Ran Downslope	6.4%
6.	Concentrated Fuel Flare-up	4.8%
7.	Gusty Cumulus Clouds Overhead (Downdrafts)	4.0%
8.	Wake Turbulence	0.8%
9.	Equipment Failure	0.8%
10.	Other (heart attacks, electrocution, etc.)	9.6%
		100.0%

The basic tools, thermometer, barometer, rain gauge, balloons, and anemometer, for monitoring weather were assembled by 1795. It was not until 1849, however, with the advent of the telegraph and rapid communication, that meteorology became meaningful. Organized forecasting was begun that year by Cleveland Abbe, Director of the Cincinnati Observatory.

The following year, the U. S. Army Signal Service set up a weather watch in response to pressure from the shippers in the Great Lakes area. In the spring of 1913, the U. S. Forest Service and Western Forestry Conservation Commission asked the Weather Bureau to begin a study to determine methods of forecasting meteorological conditions to help anticipate conflagrations in the Northwest United States. The following year the warning system was initiated. This marked the beginning of significant meteorological assistance to fire control agencies. World War I imposed the necessity for additional improvements in weather forecasting and by its cessation, in 1916, a fire weather service had been established. By 1924, refinements with regard to local weather forecasts culminated in what can be considered the first fire weather prognosticications. This advance was adopted almost immediately in the Northeast and by 1933 the Southern States began application in limited areas of the Appalachians.

World War II generated a surge of progress due to the rapid growth of aviation and, with the development of computers and their capability for collecting, digesting, and disbursing thousands of readings simultaneously, forecasting had arrived. The first computer forecast was prepared at Princeton University in 1950. Now, satellites are capable of providing refined data that continually improves dependability.

The rapid progress made in forecasting between the 30s and 60's remained unknown to most fire personnel in the field, and this knowledge filtered only to top staff positions at state and national levels. During the CCC days, for example, several references can be found in reviewing literature concerning the acquisition, development, and management of state forests along the New Jersey coast indicating a total ignorance of the sea breeze phenomenon and its influence on fire behavior. Today, while full-time fire professionals are aware of this threat to safety, complete understanding is limited. Based on observations and personnel of Rural Volunteer Fire Companies it is evident that this common event, along with atmospheric stability and other intricate aspects of natural influences on fire, remains clouded at best.

In an effort to attack this problem, the Film Committee of the Northeastern Area Forest Fire Supervisors Association is preparing a training film on the Ten Standard Fire Fighting Orders and Fire Tactics for use by Rural Volunteer Companies. Lynott, indicates that if, in utilizing the term "erratic" the meaning of unpredictable is stressed then, by implication, we will remain essentially helpless.

The tendency for fire to run upslope rapidly, for heads to make rapid runs, spotting, downslope winds, and downdrafts beneath cumulus clouds, translated to horizontal winds, are well understood technically. Wind shifts, one of the most common excuses presented for losing a fire under unstable conditions, are readily predictable and recognized as events that have specific identifiable causes. POST-TRAGEDY ANALYSIS SUPPORTS THE PREMISE THAT THERE IS NOTHING MYSTERIOUS CONCERNING FIRE BEHAVIOR UNDER A GIVEN SET OF CURCUMSTANCES. THE MOST SIGNIFICANT GAP IN KNOWLEDGE SEEMS TO PERSIST IN PRECISELY TIMING THE EVENT.

If local weather is monitored closely, pertinent information can be transmitted to line personnel. This procedure, in combination with behavioral explanations and adjusted tactics presented in most handbooks and training manuals, should result in concomitant reduction in fear that will improve efficiency and reduce risk.

A degree of uncertainty continues to exist regarding weather forecasts. Measurements are still somewhat crude, exact predictions are illusive due to incomplete knowledge of the atmosphere and, to the man on the ground, the process is not clearly visible. Fires, however, do not behave erratically but respond to a plethora of natural physical-chemical forces still not totally understood.

Fire accident investigations, although highly variable were undertaken for the purpose of preventing occurrence, and that failing, preventing recurrence through after-the-fact analysis. The Act of God concept, which protects

all parties to wildland fire fatalities, has been found to be unacceptable to this task force. All present cause factors will be repeated if it is not understood that there is nothing unexpected about a repeated cause factor that has been previously investigated, analyzed, and reported. Persistent recurrence cannot be considered an accident.

Perhaps the most regretable aspect of all fatal fires reviewed was the individual and collective cost of the sacrifice compared to the description of values protected. The investigation, in most situations, identified the cause and effect relationships accurately following the tragedies.

The development of fire behavior teams, recommended by Chandler and Countryman, have been most effective for evaluating the behavior of many major fires. However, their services are severely limited. Most data provided at the state level is inadequate and apparently destined for further reduction by budgetary constraints.

Recommendations:

1. The development of mutual strategic priorities among all agencies engineered toward a more effective command structure, personnel and equipment utilization, and a refinement of operational procedures based on forecast and observed fire behavior. This might best be developed at the state level through federal forest fire training grants.

2. Nationwide revision of suppression policy embracing DESCON (Designated Controlled Burning System) for all wildland types in which this practice is ecologically, environmentally, and economically acceptable. If, in fact, the combination of probability and severity makes the risk factor unacceptable this method may decrease risks to favorable levels by providing workers more on-the-job fire behavior analysis training and allowing fires greater latitude. Crew operational tasks must be reviewed, evaluated for risk, maneuvers adjusted for safety, and alternate techniques provided where possible to minimize hazard.

3. Professionalization of fire staff personnel at lower management levels for in-depth development of fire behavior analysis capabilities. (See also Recommendation #1 under Accountability, and Recommendation #2 under Human Behavior, in this Report.)

4. A National standard forest fire accident analysis format to establish root fire behavior causes more effectively and creation of a permanent interagency fire study team issuing an accident newsletter through an established medium.

5. A Fire behavior specialist for each state or province exhibiting serious hazards.

6. The development of computerized fire behavior simulation games.

7. Inexpensive, reliable, automated fire weather stations.

8. More detailed forecasts at each primary headquarters with maps of latest synoptic weather.

9. Increase support to the National Weather Service for the purpose of acquiring more fire weather forecasters.

10. Continued fire weather research and improved communications.

AIRCRAFT EFFECTS ON FIRE BEHAVIOR

Issue:

The potential hazard of wake turbulence and rotor vortices, pertaining to fire behavior and crew safety.

Discussion:

In 1919, sixteen years after the Wright brothers completed their historic flight in Kittyhawk, Coert Du Bois, U. S. Forest Service, and Hap Arnold, Army Air Force, met in a San Francisco bar. This meeting culminated in an agreement to try aerial detection of forest fires in the Sierras, using Jennys from World War I. In 1947, following World War II, evolutionary development of aircraft stimulated a renewed effort with helicopters for scouting, hose lays, fanning backfires, transporting men and equipment, and with fixed-wing aircraft for bombing forest fires.

Light helicipters in the Hiller 12-E, Bell 47-G class, capable of carrying 55-gallons of water; and fixed-wing Stearman Ag-Cats and TBMs, with a capacity of 150 to 300-gallons entered the fray following experimentation with B-29s, P-47s and Fighter-Bombers. Initial support for this scheme, expressed by some state personnel, ranged from outright pessimistic hostility to enthusiastic expectations that have been more nearly realized than diffused.

In 1953, disastrous fires in southern California focused attention again on the need to develop new and better methods and ideas. Since defense against such fires is also a grave problem in civil defense, the Federal Civil Defense Administration gave assistance in various ways. With this remarkable pooling of resources and interest, an ambitious and highly successful one-year exploratory project, known as Operation Firestop, combining field and laboratory tests was carried out.

This one-year exploratory task force assembled to develop and test the field concepts of aerial attack was credited by Wilson for the successes enjoyed today.

A few progressive forestry states like North Carolina began programs as early as 1958, and other pioneering state agencies transitioned to aircraft operations in the early and mid-sixties.

Currently, detection and attack aircraft with their confirmed potential for bird-dogging and extinguishing small fires, or providing holding actions on others, are utilized by many state, provincial, and federal agencies, in a varied mix routinely. Additionally, they have been utilized successfully in fire prevention and law enforcement procedures.

Drops evaluated for effectiveness indicate that 62% provide definite help, 17% probable help, 8% doubtful help, and 13% no help; 71% are on target, 15% partial misses, and 14% complete misses. A five-year appraisal of air tanker use conducted by the U. S. Forest Service in 1968, following 12-years of trials on national forests, revealed a 20% reduction in the area burned.

Growth of the aviation tool had not been without problems. Two unique hidden impacts on fire behavior that possess great potential danger for ground crews have gradually blossomed in the form of rotor vortices and wake turbulence.

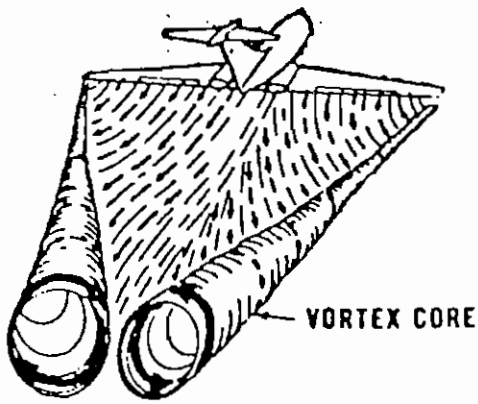
Every aircraft generates a wake while in flight. Initially, this was attributed to "prop wash", however, this disturbance is caused by a pair of counter-rotating vortices trailing from the wing tips. The vortex from large aircraft can pose real problems to line personnel, and crewmen must learn to envision the location of the wake generated and adjust their activities accordingly.

Lift is generated by the creation of a pressure differential over the wing surfact which triggers the rollup of the air flow aft of the wing resulting in swirling air masses trailing downstream of the wing tips. After the rollup is completed the wake consists of two counter rotating cylindrical vortices. (see Fig. 1).

The strength of the vortex is governed by the weight, speed, and shape of the wing of the aircraft. The vortex characteristics of any given aircraft can also be changed by extension of flaps and other wing configuring devices as well as by change in speed. However, if the basic factor is weight, the vortex strength increases proportionately. During a recent test, peak vortex tangential velocities were recorded at 224-feet per second or about 133-knots. The greater vortex strength occurs when the generating aircraft is HEAVY - CLEAN - SLOW.

Trailing vortices have certain behavioral characteristics which can help a fire fighter visualize the wake location and thereby take necessary precautions.

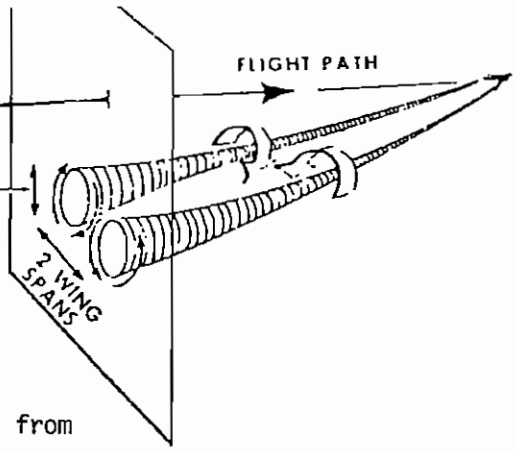
1. Vortices are generated from the moment aircraft leave the ground, since trailing vortices are a byproduct of wing lift.



VORTEX PATTERN

Figure 1

2. The vortex circulation is outward, upward and around the wing tips when viewed from either ahead or behind the aircraft. Tests with large aircraft have shown that the vortex flow field cutting through the wake at any point downstream, covers an area about two wing spans in width and one wing span in depth. The vortices remain so spaced (about a wing span apart) even drifting with the wind, at altitudes greater than a wing span from the ground. (See Fig. 2)



Vortex Flow Field in Aircraft Wake

Figure 2

3. Flight tests have shown that the vortices from large aircraft sink at a rate of about 400-500-feet per minute. They tend to level off at a distance about 900-feet below the flight path of the generating aircraft. Vortex strength diminishes with time and distance behind the generating aircraft. Atmospheric turbulence hastens breakup. (See Fig. 3)

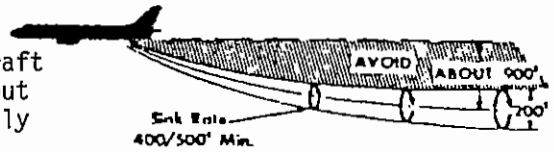


Figure 3

4. When the vortices of large aircraft sink close to the ground (within about 200-feet), they tend to move laterally over the ground at a speed of about 5-knots. (See Fig. 4).

5. Wake turbulence from heavy jets may still be active when the strike aircraft has proceeded 4 to 6-miles past the drop point.

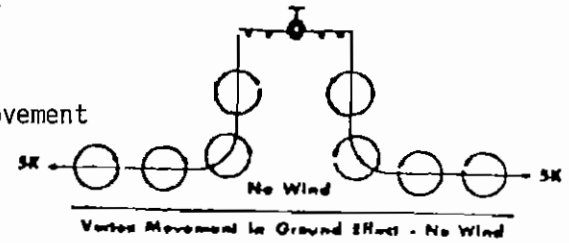
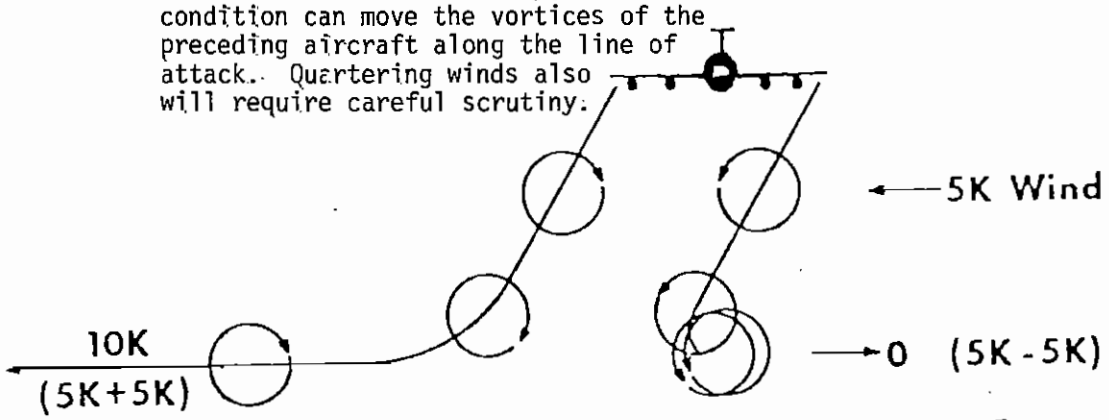


Figure 4

A crosswind will decrease the lateral movement of the upwind vortex and increase the movement of the downwind vortex. (See Fig. 5) Thus a light wind of 3 to 7-knots can result in the upwind vortex remaining over the fireline for a period of time and hasten the departure of the downwind vortex. Similarly, a tailwind condition can move the vortices of the preceding aircraft along the line of attack. Quartering winds also will require careful scrutiny.



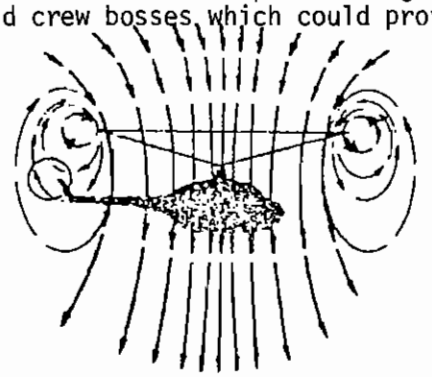
Vortex Movement Near Ground - with Cross Wind

Figure 5

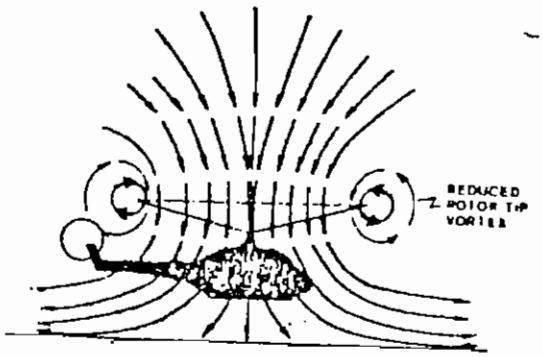
Hovering helicopters generate a downwash similar to the prop blast of a conventional aircraft, known as induced flow. (See Figs. 6 and 7) Although this induced flow is always present around the periphery of the rotor under certain airflow conditions, it can add to the already existing vortex, causing the vortex to intensify. The down wash of larger aircraft reaches velocities of 60 to 100-knots on a regular basis and a UH-1 helicopter at 9500-lbs. gross weight achieves downwash velocities of 145-miles per hours. However, in forward flight this energy is transformed into a pair of trailing vortices similar to wing tip vortices of fixed wing aircraft. (See Fig. 8)

One study initiated to evaluate the use of foam in air tankers found that the greatest foam production was generated by high speed wake turbulence which appears to be the only positive effect of this phenomenon insofar as desirability is concerned. The drift and instability of this material, however, did not appear promising for fire suppression.

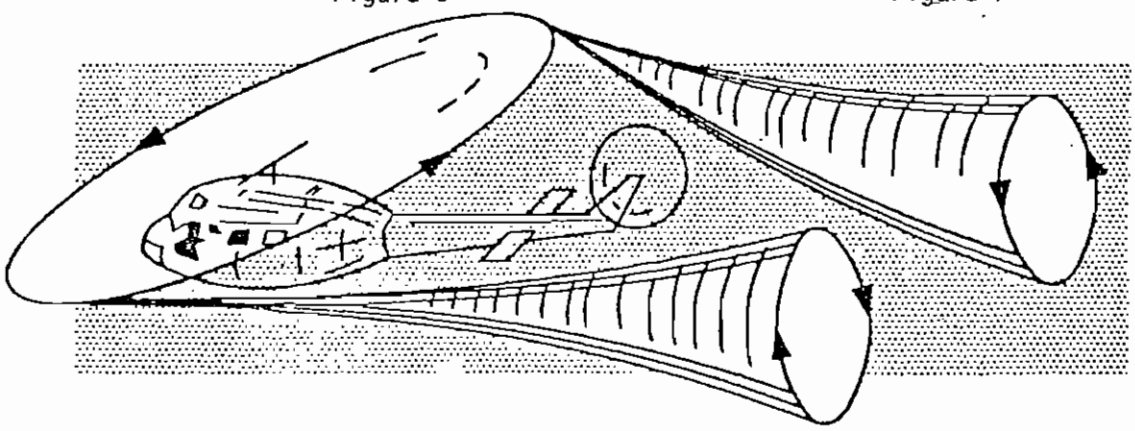
Currently, conversions of large aircraft like the C-130, DC-6 and DC-7 capable of retardant capacities of 2500 to 4000-gallons and speeds of 180 to 250-knots require increased concern and study with regard to their effects on fire behavior. In 125-fires studied, one definite and six possible accidents relating to fire behavior influenced by aircraft performance were found. However, escalating numbers of reports on behavioral influences attributable to rotor wash and wake turbulence are being received. Any deviation from safety recommendations indicates acceptance of greater responsibility on the part of ground crew bosses which could prove fatal.



Hovering Out of Ground Effect
Figure 6



Hovering In Ground Effect
Figure 7



Helicopter Vortices.
Figure 8

Recommendations:

1. Generally speaking, the area below and behind aircraft should be avoided by fireline personnel. Firefighters must be taught to visualize the location of the turbulence trail behind large aircraft and use proper avoidance procedures to achieve maximum safety.

2. It is very important that pilots of large aircraft plan or adjust their flight path to minimize exposure of ground personnel to turbulence effects. Under certain conditions, air attack bosses can apply procedures for aircraft in the communication net which, in their opinion, may adversely affect fire behavior. Lead aircraft could also be equipped with loud speakers to broadcast the phrase - "CAUTION - WAKE TURBULENCE" for ground units.

3. Turbulence visualization and avoidance procedures for helicopters should be exercised by pilots and ground crews using the same degree of concern as in fixed wing operations. Tankers should be cautioned to pull up as soon as possible and abandon the attack if personnel may be endangered. Crewmen must be taught to be alert during aircraft operations particularly down wind of the wake for an interval 2 to 3 minutes after aircraft passage.

4. As Davis and Chandler indicated, fire crews should be taught to be alert for trouble when (a) the air is still and calm, (b) the fire is burning in open brush, grasses, or scattered timber because tall or dense vegetation would greatly diminish turbulence, (c) the air tanker is large or heavily loaded and flying low and slow.

Further, the pilot should be aware of the problems his aircraft can have on fire behavior, and should abide by the following rules:

(d) do not fly parallel to the fireline more than necessary
(e) keep high (in excess of 500-feet prior to making the actual drop)
(f) insure that ground crews are alert to the presence of the air tanker and the intention of the pilots.

5. The Health and Safety Code and Fireline Handbooks should carry warnings based on the preliminary data available, and suppression training must present all aspects of the phenomenon to fire crewmen.

6. A final recommendation would be that additional monitoring and research be conducted on the mix of wake turbulence, helicopter vortices, and fire behavior in order to minimize threats to lives and property.

PRESCRIBED FIRES - MAJOR PROBLEM?

Issue:

Are Prescribed Fires emerging as a Major Problem?

Discussion

The expanded use of prescribed fire increases personnel exposure and the potential for accidents. The 1979 fire season, alone, infers that this practice could become a significant factor in fatal and near fatal fire related accidents. There were seven incidents last year where fatalities occurred. Three of the incidents involved prescribed burns. Of the 15 fatalities resulting from these seven incidents, nine fatalities occurred on prescribed burns; with seven of the fatalities in one incident. Four near misses were also reported in 1979. Two of these involved prescribed burns. There is only one recorded prescribed burn fatality prior to 1979. Some of the reasons for this recent upsurge could be:

1. The reporting system. Historical records could designate the fatality under the functional objective of the burn or just lumped in with "fire caused" fatalities.

2. Increase in use of prescribed fire during 1979.

3. Officially, near misses tend to be forgotten after a few years. (Although, certainly not by the individuals concerned. They are usually repeated as "war stories" for many years.)

4. Poor data gathering process for near misses because of no specific reporting system.

Recommendation:

The 1979 fire season does point out that prescribed fires can kill just as readily as wildfires can. Fire managers must be cautioned not to treat safety casually on these projects.

FIRE SAFETY TRAINING:

Issue:

Are the "Ten Standard Firefighting Orders" and the "13-Situations That Shout, Watch Out!" still valid, available, taught, reinforced, retained?

Discussion:

In March 1957, the U. S. Forest Service organized a task force to "study how we might strengthen our ways and means of preventing fire fighting fatalities".

The task force was selected after the loss of 11 lives on the Inaja fire, Cleveland National Forest (R-5) in November 1956. The intent of the team was to study the service-wide problem of preventing fire fatalities and to "recommend further action needed in both administration and research to materially reduce the chances of men being killed fighting fires". The task force made four major recommendations which were to be implemented during the 1957 fire season. One of those "action items" was to:

> "Adopt for Service-wide use the attached "Standard Fire Fighting Orders". These orders to be committed to memory by all personnel with fire control responsibilities."

The task force went on to say: "Militiary organizations have had long experience in training men to remember certain fundamental instructions and to react even in emergencies in accordance with those instructions. One device by which such discipline is achieved is that of "General Orders", which all men of the unit are required to memorize. On some of the fires that the task force reviewed, men who know better just did not pay adequate attention to good fire fighting practices that seem like small details but could become the critical item in an emergency. The use of a form of standard orders starting immediately would be a long step in the direction of assuring attention to the fundamentals."

There is no doubt that the idea of having "Fire Fighting Orders" had a great deal of merit. Most fire fighting personnel, inside and outside the Forest Service, know about the "Orders" and could quote general concepts of most of the Ten. However, it is likely that not one person in 10 could give them verbatim and in order. Furthermore, although the 13 Situations That Shout, WATCH OUT!! are valuable and do represent the "situations" on which fatalities and near-misses occur, they tend to confuse someone who is trying to memorize the ORDERS. Also, many fire behavior and fire management training sessions tend to present both the ORDERS and SITUATIONS at the same time. The SITUATIONS can either reinforce or confuse and are likely to do the latter. (See copy of 13 Situations list showing reference to specific FIRE FIGHTING ORDERS at the end of this subject.)

In principle, the 10-Standard Orders are still valid though they can be condensed. The concept is as correct as it was in 1957. The ORDERS

cards may be readily available, but probably most people do not carry them on the fireline. One reason is that sweat tends to make them illegible. Also, they are easily forgotten. In most fire behavior training sessions the ORDERS are taught and occasionally reenforced with slides and other visual aids. Based on limited sampling during the past several months, it is the task force's opinion that most fire fighters know about the ORDERS, but many have not memorized them by heart.

The ORDERS appear to have not been followed in most cases involving near-misses and fatal fires which have been documented since 1957. In 28 near-misses some, if not all, of the Ten Standard Orders were disobeyed. Since lives were not lost, it is apparent that at least No. 4, "Have ESCAPE ROUTES for everyone and make them known", was followed, or the individual was lucky. However, in the 48 fires involving fatalities since 1957, it is apparent that most of the ORDERS were not followed.

Recommendation:

Two major changes need to be made in the TEN STANDARD FIRE FIGHTING ORDERS:

1. They must be made easier to remember. An acronym seems to help. Since WATCH OUT! has been used with the 13-SITUATIONS, then it seems logical that it can be the acronym. In the sample which follows, EIGHT FIREFIGHTING COMMANDMENTS are proposed which protect the integrity of the original ORDERS. Moreover, each complete phrase or COMMANDMENT should be easier to recall than the ORDERS. Also, much of what is contained in the 13-SITUATIONS is in the COMMANDMENTS. It would probably be advisable not to use both in one training session but to utilize the 13-SITUATIONS to reinforce the key points needed to present the COMMANDMENTS.

2. The memorizing of the COMMANDMENTS should be mandatory and failure to quote them verbatim should be disciplined in the same manner as failure to memorize and quote the "General Orders" was.

THE PROPOSED EIGHT FIREFIGHTING COMMANDMENTS

It is easy to get behind the "8" Ball if you don't obey the EIGHT FIREFIGHTING COMMANDMENTS

W -	WEATHER	- dominates fire behavior so keep informed.
A -	ACTIONS	- must be based on current and expected fire behavior.
T -	TRY OUT	- at least two safe escape routes.
C -	COMMUNICATIONS	- maintain them with your crew, your boss, and adjoining forces.
H -	HAZARDS	- to watch for are flashy fuels, steep slopes, and chimneys.
O -	OBSERVE	- changes in wind direction or velocity, humidity, clouds.
U -	UNDERSTAND	- your instructions and make sure yours are understood.
T -	THINK	- clearly, be alert, and act decisively before your situation becomes critical.

REMEMBER, TO W A T C H O U T ON THE FIRELINE.

THE PRESENT TEN STANDARD FIREFIGHTING ORDERS

1. Keep informed on FIRE WEATHER conditions and forecasts.
2. Know what your FIRE is DOING at all times - observe personally, use scouts.
3. Base all actions on current and expected BEHAVIOR of FIRE.
4. Have ESCAPE ROUTES for everyone and make them known.
5. Post LOOKOUTS when there is possible danger.
6. Be ALERT, keep CALM, THINK clearly, ACT decisively.
7. Maintain prompt COMMUNICATION with your men, your boss, and adjoining forces.
8. Give clear INSTRUCTIONS and be sure they are understood.
9. Maintain CONTROL of your men at all times.
10. Fight fire aggressively but provide for SAFETY first.

The Present 13-Situations That Shout, WATCH OUT!

	Relevant 10-Standard Orders	Relevant 8-Firefighting Commandments
1. YOU--in heavy cover with unburned fuel between YOU and FIRE.	2, 4, & 10	A, T, & H
2. YOU--in country you have not seen in daylight.	4 & 8	A, T, & H
3. YOU--feel weather getting hotter and drier.	1, 3, & 6	W, A, T, H
4. YOU--feel like taking a nap near fireline.	4, 5, 6, & 10	W,A,T,C,H, O,U,T
5. YOU--cannot see main fire and You are not in communication with anyone who can.	2, 3, 7, & 8	W,A,T,C
6. YOU--notice wind change.	1, 3, 4, 6	W,A,O,T
7. YOU--in an area where terrain and/or cover make travel slow.	2, 3, 4, 5, & 6	W,T,C,H,T,
8. YOU--are getting frequent spot fires over your line.	7, 10	O & T
9. YOU--are building a line downhill toward a fire.	1,2,3,4,5,6, 7,9,10	W,A,T,C,H O,U,T.
10. YOU--have been given assignment and instructions not clear to you.	4,5,6,7,8,10	A,T,C,H O,U,T
11. YOU--are attempting to make a frontal assault on a fire with tankers.	1,2,3,4,5,6, 7,8,9,10	W,A,T,C,H O,U,T
12. YOU--on a hillside and rolling fire can ignite fuel below you.	All 10	WATCH OUT!
13. YOU--are in an area where you are unfamiliar with local factors influencing fire behavior.	All 10	WATCH OUT!

SURVIVAL TECHNIQUES (RE: FIRE EQUIPMENT)

Issue:

Improving the potential for survival of the equipment operator.

Discussion:

With the realization that the CCC Program must end sooner or later, field supervisors were forced to move toward mechanical fireline building techniques. Following World War II even greater impetus was provided for mechanization by the availability of army surplus and recognition of its immense capacity to reduce manpower requirements, which continues to diminish in supply.

The size and types of machinery adaptable to forest fire control are determined by field conditions of such diversity that no all-purpose vehicle can be developed to handle abrupt and frequent changes in fuels, soils and terrain.

Functional satisfaction from equipment requires units with extensive mobility, great working capacity, and maximum structural strength to assure reliability. Success for operators of all units must emphasize the importance of knowing the machine's limitations and that combination of circumstances which will defeat effective performance. Mechanical equipment has become such an important requirement that there seems to be a tendency among operators to assign themselves tasks which exceed their limitations.

The actions undertaken affecting decisions concerning methods of attack are predicated on attack forces, existing fire danger, the forecast, fire behavior observed, location, ownership, the general fire situation, environmental and physiographic influences.

Every suppression action presents serious risk and the proclivity of equipment operators to accept challenges to their magnified strength often prevails. In New Jersey, as a postmortem to 17 fatalities and 37 near misses since 1936, 10 trucks and 4 tractors have been destroyed by fire. In all cases losses have been sustained because the operators exceeded equipment capabilities with regard to slope, ground clearance, soil conditions, or stress factors combined with miscalculations of fire behavior. These losses, almost invariably, are attributable to lack of experience and inadequate doses of intensive training.

Documentation of the following case histories provides insight into opportunities that may enhance operators chances for survival in an emergency situation.

Case Histories

1. In 1958, a veteran Field Section Fire Warden with two young men, 18 and 19-years of age, were fighting forest fires burning in heavy South

Jersey fuels near the Bass River State Forest. A 90-degree wind shift resulted in the flank fire becoming a broad head, with flames 30 to 40-feet high advancing on their position. The vehicle, a Dodge W300 Power Wagon, was standing in the middle of a sand road 12-feet wide when its engine, deprived of oxygen, vapor-locked and stalled completely. The gear type pump driven by a power takeoff was rendered useless. Simultaneously, the radio failed.

The Fire Warden admonished the two crewmen repeatedly to stay in the truck since both displayed an obvious and overwhelming desire to abandon the vehicle and run. Subsequently, the warden reported that the truck was rocked violently by convection currents and microclimatic changes generated by the flames. The men could neither see nor breathe because of the smoke and the cab began to fill with sparks forced up through floor lever control openings in the cab, which ignited the seat. The warden estimated he stayed with the truck only 3 or 4 minutes during the passage of the head but indicated that the interval involved seemed more like 3 or 4 hours.

At the first opportunity, the crew departed from the vehicle, on the upwind side, and crouched beside the unit to escape the searing heat and burning seats. The warden proceeded to burn his hand severely disposing of a gas can in the truck bed which was spewing flames from the cap. While the young men escaped virtually unscathed, the older man suffered lung damage and remained on limited duty for 5-years. He has since recovered completely and retired.

2. A similar situation was experienced by two wardens in separate vehicles on a 10-foot sand road in the Bayville area of the South Jersey Pine Region in 1977. Both vehicles were Dodge Power Wagons, one of which stalled completely as a consequence of extreme temperature and oxygen starvation, while the other continued to run but without sufficient power to move. Other than the fact that the plastic suction hoses on the vehicle were melted, the men and trucks escaped with minor damage. The seat in one vehicle caught fire and both men suffered first degree burns on their faces by heat radiated through the glass. However, they were able to return to work immediately.

3. In 1976 a firefighter died while fighting a grass fire near Buhler, Kansas in Reno County. A flashover occurred from a build-up of gasses on the lee side of a windbreak. A fire truck was caught in the flashover and the firefighter working off of the back of the vehicle ran and was killed. The truck also burned. The driver was not seriously hurt.

4. In a 1962 CDF Fresno County fire, three men, followed by a flank that had turned into a head fire, raced back to the vehicle only a few feet ahead of the flames, jumped into the cab and rolled up the windows. The truck had vapor locked and would not restart even though it had been left running at high RPM. After the main body of flames passed over the vehicle, the three men jumped out so they could breathe since the truck was burning. Almost completely blinded by the smoke and heat, they stumbled headlong into matted fuels and received first and second degree burns. The third man was not burned, but had to be treated for smoke inhalation. The truck was a total loss.

5. In 1959, two CDF trucks on the Decker fire were trapped by a large firewhirl, however, the crewmen in cab received only light burns.

6. In 1959, on the Flat Fire, Boise BLM District, Idaho, two ground tankers in tandem were working a fireline in a flanking action on a small ridge in the Southeast sector. It was burning in sage and grass with flames three to six feet; wind was approximately 10 miles per hour and parallel to the fireline. The wind shifted 90-degrees causing the fire to run directly at the lead tanker. The engine died and the fire completely engulfed the truck. The driver had some difficulty releasing his seatbelt and was burned when flames came through the window. The fuel tanks on the truck did not explode, although they developed expansion leaks.

The following is quoted from an article by N.P.Cheney with regard to utilizing vehicles as survival shelters.

> "A number of popular misconceptions cause many persons to panic and sometimes flee a safe refuge if trapped in a fire. Over a period of several years studies by officers of the Forestry and Timber Bureau in Australia have produced information to aid human survival in bush fires. To study the performance of a car as a shield against radiation, cars were subjected to intense radiant heat from windrows of burning pine slash. The car windows cut down radiation inside to around half that received outside at the peak of the fire, but the person inside would have suffered severe burns to any bare skin. Although air temperature inside the car did not rise to a hazardous level, smoke from smoldering plastic and rubber materials caused severe discomfort. Furthermore, research has shown that the standard gas tank is unlikely to explode. When the tank contains gasoline the space above the liquid contains a mixture too rich in gas vapor for an explosion to occur.
>
> In spite of warnings and precautions situations will probably develop in which fires threaten and trap car travellers. In a grass or forest fire the main cause of death is heat stroke in an extreme form as a result of excessive heat radiation. Even in the worst situations it will be some minutes before the vehicle catches fire; if it does you can leave, but use every means to protect yourself from radiation. As mentioned, the period of intense heat in the test exceeded that which would be experienced in most forest situations, and was far greater than would ever be experienced in grass fires."
>
> The following advice was offered on how to survive in forest and grass fires."

"1. Do not drive a motor vehicle blindly through heavy smoke. Switch on headlights and park adjacent to bare areas beside the road as far away as possible from the leading edge of the fire, or park where roadside grass is shortest.

2. Wind up the windows and shelter from radiation beneath the dashboard with a rug or some other article (such as a floor mat) covering your body. If the vehicle catches alight you can leave it, but keep your skin covered as much as possible.

3. Remain calm and have confidence that the petrol tank will not explode and that even in the worst situations it will be some minutes before the vehicle catches alight.

4. In a grass fire the flames will last for 30 seconds or less and the chances of survival are very good. In a high intensity forest fire the flames will last for three to four minutes and your chances of survival are lower, but they will be better in a vehicle than in the open."

" Behind all these instructions are three basic principles which must be remembered at all times:

1. Select an area where there is the least amount of combustible material.

2. Use every means to protect yourself from radiation from the flames.

3. Remain calm and don't panic."

The National Highway Traffic Safety Administration has repeatedly warned drivers that carrying gasoline in the trunk of a car is tantamount to riding around with an explosive threat equivalent to 14 sticks of dynamite. Drivers are advised to consider carrying extra fuel only in extreme emergencies. Additionally, the Ford Pinto problem and flaming car crashes staged for television have reinforced general public concern. However, the New Jersey Supervisor of Forest Fire Equipment, with the help of lead wires, ignition harness and spark plugs has attempted, unsuccessfully, to detonate fuel tanks. It is important that the fear of explosions, among equipment operators, be allayed.

The first and most obvious effort to eliminate accidents is the construction and design of tools and equipment to reduce their potential. Millions of dollars have been spent designing vehicles for highway safety, yet, accidents still occur. Heavy firefighting equipment was designed for the commercial market and customized, in varying degrees, for the forest fires. Seats and floor mats burn

readily and protection from radiation through windows leaves much to be desired. Purchasing agents, if not closely monitored, will order trucks with highly flammable undercoating. Cooling fans on one new tractor model are capable of sucking sparks beneath the unit into the engine. The old models did not.

Schoonmaker reported that during the 1973 spring fire season one 1972 four-wheel-drive, one-ton fire truck caught fire and the cab was completely destroyed due to an engineering defect rather than operational carelessness.

While using the direct attack method on a fire in the New Jersey Pines, the operator noticed flame activity beneath the vehicle. At the same time, the engine quit. The operator looked under his truck to discover that the fuel line had been broken and burning gasoline was being siphoned from the truck. Without the engine, the pump was useless so efforts by the driver and helper to extinguish the fire failed. By the time help arrived, the cab was destroyed.

When the mechanic inspected the damaged vehicle, he discovered the fuel line was burned rather than ripped apart by brush as had been theorized. Further investigation revealed the fuel tank vent pipe was about an inch away and pointing to the neoprene fuel connecting line. The vent pipe discharge was ignited and the flame burned through the neoprene connector. Once the line was broken, there was no way to stop the gravity fuel flow.

The solution required: (1) replacement of neoprene connecting hose with copper coil tubing, (2) extension and movement of the fuel tank vent pipe to a more suitable location, (3) addition of a vented gas cap to prevent a partial vacuum or pressure developing inside the tank.

On another current truck model the gas tank is plastic. This material provides excellent resistance to rupture, through crushing, but is easily penetrated with a blow torch. Consequently, these tanks are being mounted in split 55 gallon drums for improved protection. Gas tank filler necks frequently simulate flame throwers by spouting flames, however, an explosion has never been reported on a vented tank in New Jersey.

Tractor and bulldozer fire suppression operators dovetail expanded hazard with a reduced opportunity for survival. Generally, survivability is increased dramatically and in direct proportion to coordination, team work, operator knowledge of fire behavior, and experience.

Since the inception of tractor-plow operations, tractor-tractor or tractor-tanker teams have been advanced as a best practice, but this advice is frequently disregarded. An inspection of tractor fatalities all too often finds the victim working virtually alone. In several state budgetary constraints or custom were preferred as justification for this procedure.

In New Jersey, the majority of fires attacked directly are circled counterclockwise with the tanker crew burning out in close pursuit of a tractor operating in low gear. Or, the fire is extinguished ahead of the truck so the operator can turn into burned ground. Tanker operators keep their window open in order to gauge the intensity of heat and smoke being sustained by the nozzle-man riding behind the cab.

Topographic or vegetative obstacles in the cases reviewed have been challenged by operators with tragic results. It appears that the three most common options available to tractor operators in order of priority are (1) the 180-degree turn and flight to burned ground, (2) direct penetration of the flank prior to its generation of fatal temperatures, (3) clearing an area to mineral soil and utilizing the machine as a heat shield. Operators, properly clothed and shielded, have realized a second chance adhering to this strategy.

Safety margins may also be expanded by the addition of heat screens or engaging in night operations.

Recommendations:

1. Review, update, standardize, and distribute nationally, the 40-hour Equipment Operator's Training Course developed by a task force of the Wisconsin Department of National Resources. This course includes comprehensive instructions for most problem survival situations. Scrutiny of the individual personalities involved in fire management activities leads this task force to believe that equipment operators would benefit most from the emphasis of more "hands on" training in addition to their academic curriculum.

2. Nationwide Federal Grants or Cost Sharing legislation, federally administered, for wildland fire management training and safety programs since, at the state level, these programs are generally the first to be discarded by economy measures.

3. Additional research and empirical experimentation at the Equipment Development Centers on the subject of equipment utilization as shelter.

4. Include preliminary findings in Health and Safety Code Handbook.

5. Local suggestions emphasized;

   (a) providing the capacity for filling cabs with foam on demand.
   (b) development of a miniature self-contained mask and breathing apparatus.
   (c) spray nozzles on bumpers or under trucks for the purpose of providing refuges.
   (d) safety helmets with earphones for tractor radio communications. (flight helmets)
   (e) electric fuel pump, as backup, to avoid vapor lock.

(f) portable rather than power take off pumps on firefighting units.
(g) armored engine compartments to protect distributor caps, fan belts, spark plug wires, master cylinder.
(h) guarded gas tank filler necks, protected gas caps, and air tight gas cans.
(i) slide windows in back of cab for oral communication.
(j) FWD lever guards to prevent sparks from entering cab.
(k) fireproof seats and floor mats.

S-480 DRAFT REVIEW

Issue:

Review of Draft S-480

Discussion:

The review of the Draft S-480 fire training course, Safety Chief II, was conducted by one member of the task force. The review did not reveal any shortcoming in the course. Much of the material was in outline format, and without hearing the course presentation, very little judgment could be made.

Conclusion:

No recommendations.

TWO APPROACHES (STATE & FEDERAL) TO A FIRE SAFETY TURNAROUND:

Issue:

California has some of the most dangerous wildland firefighting to be found anywhere. It is not surprising, then, that some of the worst firefighting tragedies have occurred there. The U. S. Forest Service, Region 5, and the State of California, Department of Forestry, each have aggressive programs underway to combat the problem.

Discussion:

The California Department of Forestry, since 1977, has utilized fire survival training on a widespread basis. Actual case histories of fire fatalities are studied in classroom situations. The reasoning is that there is much more to be learned from fire tragedies after management review of the investigation report is completed and filed. The objective is prevention of similar occurrences. The case history information is presented as something the student can learn from to survive similar circumstances. Fault-finding is avoided.

The course has been put on for various counties, state and federal groups--and it has been received enthusiastically. Specific areas of interest are emphasized, as desired by the recipient group (fire behavior, need for physical fitness, etc.). Instructors report that managers, when they are among the students, are often perplexed and enlightened regarding the tragedies. Additionally, it helps them become current on real-world conditions.

The course requires 8-hours and is generally taught by two instructors. Usually 14 fatal fires are covered. Among the training devices used are: color slides, tapes of interviews with eyewitnesses, the 13-Situations That Shout WATCH OUT!, and Carl Wilson's article on "Fatal and Near Fatal Forest Fires, the Common Denominators", in the November 1977 issue of International Fire Chief. The common denominators are emphasized "over and over again" as being critical to survival. Newspaper clippings, investigation reports, photographs, and similar aids are also used.

The "Safety First" Program was started in Region 5 of the National Forest System in 1972 because of dissatisfaction with the fire safety record. For example, four men were burned to death on two fires in 1971, and 19 were killed during the previous decade.

So, the Region decided to do something about the situation and the poor record. First, they formed the "Sensing Task Force" with the objective of establishing cause. Next, top line managers were involved from the Regional Forester down to the ranger district fire management officers. The purpose of this assembly was to examine the safety problems which had been identified. This feedback and followup process, according to R-5, was the key to success. Those who were the most concerned were involved, and they became committed to the effort.

What were the results?

1. There was a reduction of serious injuries in fire suppression during the first field season following the introduction of "Safety First". There has been no fire behavior-related loss of life on a Region 5 forest fire since 1971.

2. There was a complete revamping of the fire qualification system and a renewed faith in the leadership of the firefighting force.

3. There was an increased awareness by R-5 fire people of their individual responsibilities for efficiency and safety, and that accidents are not the fault of the system or procedure.

4. There was a renewed interest in physical fitness in the Region.

5. There was the development of training a team to provide leadership on large fires.

The Regional Safety Officer was quoted as saying in 1974 that, "Safety First has changed how we fight fires in the Region. It has changed how we look at our leadership for physical qualification and our own individual responsibility in recognizing and dealing with dangerous situations. It has succeeded in bringing us closer to our cooperators in the firefighting business. And it has helped us save lives." (Brian McGuire, Fire Command, April 1974.)

Dick Millar, former Director of Fire and Aviation Management for R-5, said he considered that the following specific actions under the auspicies of "Safety First" helped in reducing the loss of life on fires since 1971:

1. The Red Card Qualification System (NIFQS) has become mandatory.

2. The Step Test is required for all those persons who have fireline duties.

3. Training has been improved at the ranger district level.

4. The use of the Regional Fire Team has proven helpful.

5. Performance on fire assignments is evaluated critically.

6. Better financing of yearlong fire personnel has strengthened the fire force.

7. Strict requirement on the use of shelters is enforced.

8. Minimum performance requirements on experience are strictly adhered to.

The "Safety First" program was the launching pad for the efforts described above.

Recommendations:

1. Continue and improve the use of the National Interagency Fire Qualifications System (NIFQS).

2. NWCG should advocate the use of the case-study method of fire safety training based on lessons learned from past tragedies. Adapt the training presentations to the locales of concern. Study case histories from the local areas.

3. Use an existing method of national fire information distribution to circulate brief recaps of fatal/near-fatal fire accidents and incidents promptly. Give the key points that are important in preventing similar occurrences.

CARBON MONOXIDE & IMPAIRED JUDGMENT

Issue:

There is evidence to indicate that carbon monoxide exposure experienced by wildland firefighters can cause irrational behavior and impair the judgment of firefighters.

Discussion:

There are numerous examples of irrational behavior on the part of firefighters who became fatalities. The reports examined contain, in almost every case, indications of experienced and trained individuals, as well as inexperienced, behaving in a way contrary to training or what you would expect a prudent person to do in similar circumstances.

Countryman, in his publication "Carbon Monoxide: A Firefighting Hazard" (Pacific Southwest Forest and Range Experiment Station 1971) points out that CO in low concentrations, 50 PPM such as might be found on grass fires, impairs alertness, judgment, vision and psychomotor functions. He also pointed out steps to be taken to reduce the hazard of CO.

1. Train key personnel in the hazards of CO.

2. Shorten tours of duty in "hot-line" situations.

3. Provide for close monitoring of supervisory personnel in critical fireline situations.

4. Limit operation of vehicles by persons likely to be exposed to CO.

5. Locate fire camps in smoke-free areas.

6. The task force is not aware that any of these recommendations have been implemented or that the field is generally aware of them. There is no work being done in this field at the present time that could be found.

It is possible that many of the fire vehicular accidents are attributable to the effects of fatigue and CO.

Recommendation:

1. Implement the Countryman recommendations.

2. Institute further physiological studies on wildland firefighters to find out the magnitude of the indicated problem.

3. Monitor CO levels on wildland fires and develop predictive capabilities to warn of hazard areas.

EQUIPMENT

Issue:

The Impact of Equipment, both Communications and Suppression, on Accidents.

Discussion:

The lack of communications equipment or its failure is often thought to be a cause of fire fatalities. A review of the recent fatalities and near misses does not prove or disprove this concept. Some problems are noted in recent reports. However, a major shortage of communications equipment was not identified.

Equipment, other than communication, has played a significant part in numerous fire fatalities and near misses. These can be analyzed in several ways: lack of knowledge by equipment operators of fire behavior and the equipment's operational limits; improperly maintained equipment; and poorly maintained equipment, used improperly, or improperly placed in hazardous situations.

A combination of poor fire behavior knowledge and the equipment limitations gets many people in trouble. Two significant situations are evident here:

1. An operator maneuvers the equipment into a place or position that is not compatible with the behavior of the fire. An example of this may be a tractor plow driver trying to cut off a fast moving fire. The result is the action taken is not sufficient to stop the fire's movement and places the equipment and operator in a hazardous situation.

2. An operator gets the equipment into a place or position that the equipment was not designed for. An example is a 4X4 in excessively steep terrain. The vehicle gets stuck and the fire moves through the area, placing the operator in a hazardous situation.

Incidents were reported where equipment breakdown resulted in a hazardous situation: "Skidder stalled," "Tanker died," "Tractor plow stalled," etc., resulting in the fire burning over the equipment and sometimes the operators. It is concluded that either faulty maintenance resulted in equipment failure when operated below the stress limits, or the equipment operated beyond its design. In either case the results were injury, or death and loss of equipment.

A lack of communications equipment has not led directly to fire fatalities or near misses during the past five years.

Recommendations:

1. All equipment operators must have knowledge of and training in fire behavior. This combined with a knowledge of optimum equipment performance should keep operators out of hazardous situations.

2. Ensure all equipment is in proper repair and maintenance. This includes windows in tankers, adequate fuel, and a well-tuned engine.

3. Train equipment operators to think of and be able to answer "What if" questions relating to fire behavior and equipment performance. (See also Survival Techniques section of this Report.)

IDENTIFYING AND PREDICTING FIREFIGHTER HIGH-RISK CONDITIONS

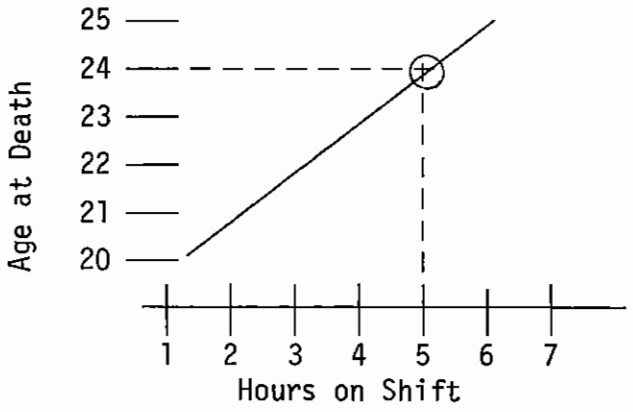
Issue:

Can Critical Points in a Firefighter's Career Be Identified and Predicted?

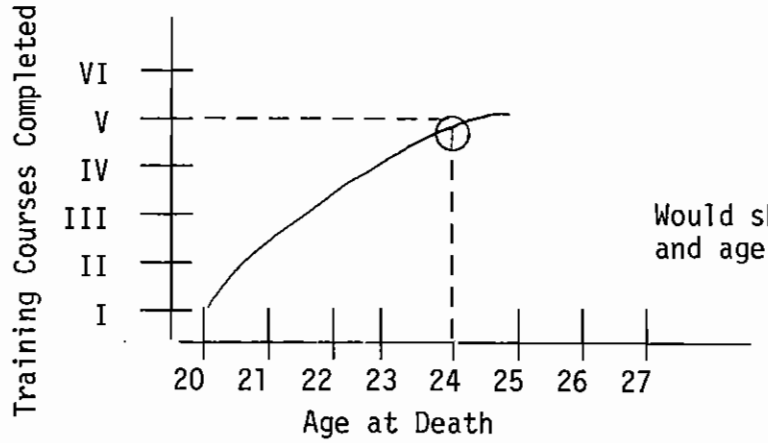
Discussion:

Using information on persons killed fighting fires, it may be possible to show a statistical relationship (correlation) between certain career variables, e.g. age at death, hours on shift when killed, number of fires attended, training completed, etc. If a relationship is found and is relatively strong, it may be possible to predict when this crucial relationship exists in others. Thereby identifying a high-risk period for individuals.

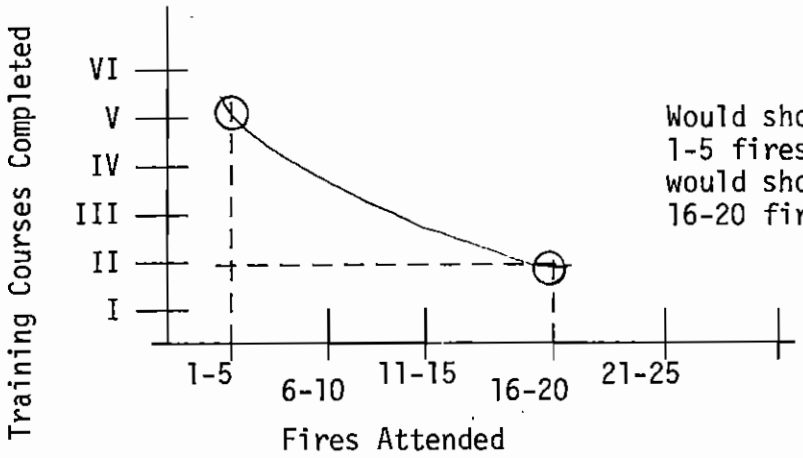
The statistical techniques used in searching for such a relationship include determination of a correlation coeficient and plotting a regression line or curve. A display of this information could resemble the following:



Would show age 24 and 5 hours on shift as one critical point.



Would show Level V training and age 24 as critical.



Would show Level V training and 1-5 fires as critical, also would show Level II training and 16-20 fires as critical.

Of course, these displays are for illustration only and do not represent actual relationships.

This type of information could be used to predict and help avoid high risk periods for individuals. These relationships could also be used by management to determine the best (safest) mix of: training and experience, age and length of shift, etc. This depth of information is currently not available in most reports. Neither is enough of this information available to attempt preliminary exploration of possible relationships. However, a reporting system similar to Recommendation 2 under the Available Information section of this report, could routinely gather this type of information.

RECOMMENDATION:

This type of analysis is deserving of further investigation.

ACCOUNTABILITY

Issue:

Almost universally, top fire management offices enunciate safety policies in strong authoritarian language. To all appearances, the concern for, and commitment to safety is number one. Yet, upon close examination, accountability is perceived to be generally weak for the correction of safety failures -- especially followup to assure correction of identified problems.

Discussion:

"Accountability", as used here, is not meant to be primarily punitive in nature -- but, rather, to mean the furnishing of a justifying analysis or explanation, as well as clear assignment and followup of specific responsibilities to assure positive problem correction. It is meant to include "discipline" in the context of training that corrects, molds, or perfects the mental facilities or moral character. "Accountability" is not meant to be synonomous with "punishment". Rather, punishment is considered to be an infrequently-used, but nonetheless necessary, element of accountability.

In both government and industry, managers have reported that effective safety programs must have "teeth" in them. This is a curious fact, because one normally assumes that people, including workers, are very concerned with protecting their own health and welfare and would voluntarily look after their personal well-being. However, the facts often do not bear this out. Workers do place themselves in dangerous circumstances when it could have been avoided; and strong measures, which include accountability as a key element, have been found to be the effective means of turning the situation around.

Investigation reveals that a problem does exist with regard to inadequate accountability for wildland fire safety. There are many reasons for this, including: "firefighters club" members not wanting to be publicly critical of each other (any accounting is usually done within the "club", and is not visible to outsiders); the difficulty of holding strangers from distant home offices accountable after the fire is out and they have returned home; and others. However, a most serious reason is that frequently firefighters are performing a tough and dirty job in a manner far beyond the normal call of duty, and management is reluctant to take any actions which would reflect adversely upon those who strive so hard. Managers feel that to be critical of these people for safety infractions would tend to further deteriorate what is already considered to be a waning interest in fire work -- with a subsequent result of the loss of those who will take on the often unpleasant fire jobs. (It is important to note that only a certain number of employees are assigned specific fire responsibilities. However, everyone is considered available in fire emergencies.)

The problem with lack of accountability is felt to exist at all levels. Many of those contacted during the course of the study felt that frequently the situation in which an accident occurs can be considered to be "set up" by management when it structures the work situation (crew size, skills mix, experience and training, leadership provided, equipment provided, subtle pressures to work under marginal conditions, fatigue, etc.). There are others, however, who see accountability for safety resting with the fire safety positions. This has the detrimental effect of weakening the clear placement of safety responsibility where it properly belongs, with the line organization.

The lack of accountability for safety failures has an opposite counterpart that leaves those seeking to instill safety accountability with an interesting paradox. That is, safety is sometimes used as an excuse for not getting the job done. The paradox is that this is a difficult rationale to criticize, since to do so has the appearance of downplaying the importance of safety or contradicting safety accountability.

Many fire supervisors feel that safety is a necessary evil -- an additional burden they must bear as they go about their jobs. They see safety as detracting from production. Because safety is mandated, they must put up with it, however they really don't feel it to be a very important part of their supervisory responsibilities. These supervisors feel that individuals should really be able to do their jobs safely without having to be repeatedly warned and corrected.
When corrective actions are identified through accident investigations, inspections, etc., followup to assure implementation is sometimes lax. This results in less than optimum risk reduction; and it also is viewed by workers as a weak management commitment to safety -- as evidenced by the lack of interest in followup. Many fire managers contacted during the course of the study asked: "How do you hold someone accountable for a lack of initiative -- or an attitude of assuming that someone else will do it, and 'it isn't my responsibility if I wasn't told specifically to do it'?" They feel that there is a strong "never volunteer for anything" mentality that is very similar to that so familiar in the military during massive mobilizations. They see a kind of fatalistic acceptance of mediocrity and foulups in fire operations, and a feeling of inevitability for the consequential fire escapes or accidents/incidents. They feel that there is not enough accounting made for the details leading to foulups.

To hold an individual accountable, that person must first have been made responsible and given corresponding authority. Frequently, fire organizations are non-standard enough that the standard fire job descriptions and organizational structures do not clearly place the responsibility -- and the managers on the fire, for one reason or another, do not specifically clarify who will be responsible for what. Out of situations like this, personnel are placed in unsafe situations.

Along this same line, supervisors are often perceived to take the easy way out when subordinates foul up by stepping in and taking over to

correct the situation. This common practice in fire, rationalized as necessary because of the emergency nature of the job, is counter-productive. The subordinates are not able to learn by developing a plan and following through with it on their own to improve and correct it, with the supervisor's counsel, to get the proper job done. In effect, accountability has been removed from the subordinate.

As Allen found in 1974, "A close personal relationship, delegation of authority, and emphasis on development of the subordinate are necessary (for effective leadership, accountability and effective training)".

On the subject of punishment, there is a widespread belief among fire managers that the methods to punish deserving employees exist, but they are so tedious and time consuming that punishment is usually avoided when it is warranted.

Recommendation:

Emphasize professionalism among those who do fire work, and upgrade the prestige and recognition given to them, so that accountability can be instilled without counterproductive results. The desire to be a part of a prestigious organization, and the rewards to compensate for the tough work conditions, should be very effective for attracting and developing personnel who acknowledge their accountability as "pros", for the safety of their fire job performance. The following specific actions are recommended.

1. Integrate safety into proper job performance for all positions so that performance is clearly recognized, in performance evaluations, as not being at a professional level when safety is lacking. Then, accountability for safety will take place in the same manner as accountability for production. Utilize slogans, poster campaigns, training sessions, and all other possible opportunities to get the message across that "you are not a pro if you aren't safe". Bring safety around from being almost an incidental consideration in job performance to being a key measure of proper job performance. Integrate safety into fire in a manner similar to the way it is in aviation. Safety should be viewed as essential to correctly doing the job. Poor handling of safety in the performance of duties should carry a negative stigma. The concern supervisors feel for production should be used to advantage. They need to be brought to realize that work interruption and loss of production are two very visible results of accidents and injuries. Once they can see that a job performed unsafely is a job not performed correctly, then they themselves will voluntarily instill accountability for safety into their operations -- rather than management having to "force feed" safety down from the top. (See also Recommendation #2 under Human Behavior, and Recommendation #3 under An Inspection of Erratic Fire Behavior, in this report.)

2. Increase the rewards to those who do good fire work so that it becomes important to people to become fire professionals, whether in full-time or incidental capacities. Good fire performance needs to contribute to advancement in the organization. Administrative procedures should be established to do this. This should be true

especially if the individual's primary job is something other than fire. Emphasize the use of monetary bonuses, awards, and other "esprit"-building rewards to those who do good, safe fire work.

3. Be sure the best, most respected fire professionals go into the fire safety positions. This will elevate the status and prestige of safety, and workers will pay more attention to it. Give the safety positions the power and authority to approve, modify, or shutdown fire operations, depending on safety considerations. Then see to it they exercise that authority. In this way, accountability can be emphasized without damaging the desire of individuals' to take part in fire operations.

Appendix A

USFS FATALITIES

Name of Fire, National Forest And Year	Number Involved	Fire Behavior	Remarks
King's Canyon Toiyabe 1926	5	Unexpected downslope wind on lee side of Sierra pushed fire into second-growth forest with understory of brush.	Men had gone downhill for water and were trapped on road when wind changed
Dollar Mt. Colville 1929	1	Sudden wind change in relatively light fuels.	Man tried to outrun fire uphill.
Kamus Burn Okanogan 1933	2	Fire in light fuels and wind changed direction.	Men tried to outrun fire but failed.
Blackwater Shoshone 1937	15	"Sudden wind" caused fire to blow up in heavy Douglas-fir re-burn. Spotfire made a run uphill toward men.	Men went in from top toward sootfire - then it flared up. Part of crew found safety on rocky point.
Welcome Lake Huron 1937	1	Early spring fire, strong, dry winds from West. Fire crowned in jack pine and red pine plantation.	CCC foreman was pulling his crew out when it started to crown. He was looking for 2 of his men and was trapped and died 100 feet from safety.
Rock Creek Humboldt Toiyabe 1939	5	Sagebrush and grass fire made an "unexpected run" upslope and trapped boys.	Five CCC boys from Paradise Camp were burned to death on fire near head of Rock Creek.
Silver Plume Lincoln 1940	1	Sudden wind change and fire flared up.	Man sleeping outside fire line.
Williams Hills Los Padres 1943	1	Fire made a run in chamise and buckwheat.	Cat operator was building line in advance of fire. Cat threw track, and operator tried to escape fire.
Hauser Creek Cleveland 1943	11	Sudden wind shift under slackening Santa Ana conditions - maximum wind 8 miles/hr. SW.	Crew of Marines caught in small canyon off main Hauser Creek (72 were injured).
Hot Springs Payette 1944	1	Man found in sitting position on trail. Fire burned around him.	Suspected heart attack or other health problem.

USFS FATALITIES

Name of Fire, National Forest And Year	Number Involved	Fire Behavior	Remarks
Bryant Canyon Angeles 1947	1	Spotfire below men burned upslope trapping men in unburned fuel.	Burning rat ran out of main fire into next. Spotfire spread uphill under man.
Barrett Dam Cleveland 1948	1	Winds changed at night from SW to East and fire flared up.	Man became separated from crew.
Walton Spur Stanislaus 1949	1	Swirling winds in light fuels in Tuolumne River Canyon.	Tractor operator trapped above fire.
Warm Springs Payette 1949	1	Unexpected strong winds caused flareup.	Man dropped behind crew to eat lunch and was trapped.
Hells Canyon Payette 1949	1	Fire fanned by high winds.	Man stumbled and fell into fire.
Mann Gulch Helena 1949	13	Rapid spread in light fuels burned upslope. Hot, dry weather.	Smokejumpers jumped into unburned basin, and fire fishhooked below them. Most men failed to use area (burned area) and were caught going uphill.
Rattlesnake Menodicino 1953	15	Unexpected evening downslope wind caught entire crew eating lunch on a spotfire.	Part of crew tried to outrun fire downhill.
Tunnel No. 6 Tahoe 1954	3	Mono (dry east) winds caused flareup at night.	Men were sleeping in unburned area at edge of fire.
Sagebrush Cyclone Malheur 1955	1	Fire was being mopped up in sage and grass. Down drafts from cumulus cloud caused unexpected wind.	Man was separated from crew and tried to outrun fire.
Johnson Prescott 1955	1	FDR "Extreme," and fire made run in light fuels.	Man tried to outrun fire uphill.
Inaja Cleveland 1956	11	Upslope wind in evening when Santa Ana winds eased. Fire ran uphill.	Crew working on indirect line in steep canyon. Fire fishhooked under them, ran upslope and caught them before they could reach safety.

USFS FATALITIES

Name of Fire, National Forest And Year	Number Involved	Fire Behavior	Remarks
East Highlands San Bernadino 1956	1	Upslope winds in light fuels after Santa Anas tapered off at night.	Tractor operator trapped before he could reach safety.
Stewart Cleveland 1958	1	Minor flareup in chaparal under weakening Santa Ana conditions.	Out-of-region man scouting in brush ahead of fire.
Albert Ranch Angeles 1958	1	Minor flareup as wind changed at night.	Man was trapped ahead of fire.
Gun Angeles 1959	1	Minor flareup. Fire in front country canyon and wind changed.	Man was laying hose uphill was caught by fishhook run.
Decker Cleveland 1959	5	Downslope afternoon wind stopped and fire came upslope in early evening.	District Ranger and four men were on state highway when fire came upslope and caught them in the open.
Stable San Bernardino 1959	1	Very hot and dry, unstable atmosphere.	Tried to outrun fire but apparently had heart attack.
Dry Sequoia 1959	1	Unexpected downslope afternoon wind on east-facing slope.	Two men were returning after going downhill to get water. Fire came downhill and trapped them.
Cummings Cr. Umatilla 1960	1	Unexpected wind change in light fuel on ridge.	Man dropped behind and couldn't keep up with crew when fire flared up below them.
Sierra Angeles 1961	1	Sudden, unexpected wind change.	Man unable to gain safety in time.
Silver Creek Nezperce 1961	2	Fire spotted in extremely steep terrain in light fuel under gusty wind conditions near the bottom of the fire.	Crew went to a chute above spot fire, but all except two men left chute when danger was obvious. One man had asthma and had to move slowly.
Timberlodge Sierra 1962	4	Hot, dry, unstable atmosphere and light fuels. Loaded B-17 air tankers flew low over fire.	Tornado-like action from air tanker vortices probably caused fire to blow up and trapped men.

USFS FATALITIES

Name of Fire, National Forest And Year	Number Involved	Fire Behavior	Remarks
Coyote Los Padres 1964	1	Downslope wind through Romero Saddle in early afternoon.	Man panicked and ran to lower part of saddle where the temperatures and carbon monoxide concentrations were too high.
Loop Angeles 1966	12	Unexpected upslope wind in afternoon after Santa Ana stopped.	Fire fishhooked under crew in a chimney and part of the crew couldn't reach safety in time.
Balliff San Bernardino 1967	1	Flareup at night in light fuels on steep slope.	Fire fighter fatally injured when he fell trying to escape flareup.
Sundance Kotenai 1967	2	Fire blew up and made major run toward north under strong wind conditions.	Operator and man with tractor were ahead of fire and tried to hide under blade.
Slaughter Apache 1967	1	Fire became intense in pre-commercial thinning slash.	Fire boss tried to outrun fire and couldn't hear warning calls from crew on road.
Williams Coronado 1968	1	High temperatures, local gusty winds-cumulus clouds near fire	Burned trying to outrun fire.
Canyon Angeles & L.A. Co.F.D. 1968	8	Santa Ana weakened, and unexpected wind pushed fire upslope in late morning.	Men tried to outrun fire uphill after flareup in brush below them.
Romero Los Padros 1971	4	Strong, "Sundowner" (Santa Ana) evening wind pushed fire downhill.	Bulldozer operator and 3 men burned as they hurried downhill to find safety.
Banning San Bernardino 1971	1	Fire ran upslope in early evening. (also known as "Mack 2 Fire")	Member of tanker crew was laying hose downhill from road at night.
-- Ashley N.F. 1977	3	Fire overtook crew on steep slope in sagebrush-grass.	Wind changed on steep slope -- small fire.
-- Okanogan, N.F. 1977	1	Foreman was scouting and got lost in sage & pine.	Helicopter tried to find man but couldn't.

USFS FATALITIES

Name of Fire, National Forest And Year	Number Involved	Fire Behavior	Remarks
Ship Island Salmon N.F. 1979	1	Crew member and others were in helispot when fire came up.	Man put on shelter near pile of gear and died.

Appendix B

OTHER AGENCY FATALITIES

NAME OF FIRE	NUMBER INVOLVED	FIRE BEHAVIOR	REMARKS
Griffith Park California 1933	25 killed plus 128 injured	Fire burned in light chaparral near Griffith Park. Wind changed.	Men tried to run for safety, but 25 failed.
Chatsworth New Jersey 1936	3 - CCC 2 - volunteers	Grass and trees.	Were back-firing when wind changed.
Pepper Run Pennsylvania 1938	8	Fire burning in mixed-hardwood leaves on fairly steep slope. Wind shifted and crossed fireline below men. Final size 134 acres.	Squad foreman told men to run for safety. All ran up the hill and were caught by the fire.
Kawailoa Hawaii 1941	2	Flashy fuel and the wind changed unexpectedly.	Two men were unable to gain safety in thick staghorn fern.
Glenville Dist Arkansas 1952	1	Sagebrush & grass, high winds, high FDR and fire threatening homes.	Individual fighting fire fell in path of fire (from exhaustion) and died.
Bonnie Blue Virginia 1953	1	Fire burned rapidly up steep slope.	Man became separated from main crew and was burned.
None N. Carolina 1953	2	Woods fire.	Woman (age 82) and child (age 11) were burned in woods fire trying put it out.
Gap Creek Tennessee 1954	3	Strong winds pushed fire upslope and it crowned.	Men were trapped on slope above fire.
Hacienda California 1955	5	Light fuels high temperatures, low humidity and unstable atmosphere. Fire threatening homes.	Foreman and crew were in bowl-like area when flashover occurred.
Brickyards New Jersey 1955		In woods on spot fire.	Fire surrounded driver, and he burned to death along Turner's Rd.
Pennington Texas 1959	1	High winds in grassy fuels.	Man on road grader got in front of head of fire and was killed.
Siler City N. Carolina 1960	1	Fire in grass.	Man burned to death while attempting to put out grass fire.

OTHER AGENCY FATALITIES

NAME OF FIRE	NUMBER INVOLVED	FIRE BEHAVIOR	REMARKS
Unnamed Georgia 1960	8	Ordinary. Control burn escaped.	All 8 men were shown as dying of heart attacks. (Only 3 were 70+)
None Florida 1960	1	Light fuels and unexpected wind change in sedge.	Two men on jeep. One ran to safety.
None Georgia 1963	1	Control burn escaped.	Men overcome by smoke and/or coronary.
Joshua Falls Virginia, 1964	1	Fire burned up draw toward men.	One man apparently refused to follow leader and was killed by heat.
Fairview Hollow Kentucky 1965	3	Small fire (26.6 acres) near town, light wind. Fire burned in a small hollow with 40-65 degree slope. Fuels were light carpet of leaves of beech, oak, maple, basswood and poplar.	Men ran up the hill ahead of fire but were trapped on steep slope.
Heiker N. Carolina 1965	1	Wind speed increased. Fire in broom sedge.	Was helping on control burn. Was caught in wire fence & burned to death
Windsor S. Carolina 1967	1	Weather dry & windy. Fire (4,000 acres) was fast-moving and erratic in pine.	Man was trapped by fast-moving head fire in dense smoke; couldn't escape.
None Mississippi 1967	1	Small fire, flashy fuels, gusty winds.	Man backfiring but lost backfire. Died after 3 days in hospital.
Range Fire Kansas RFD, 1967	1	Fire in dense grass.	Man panicked and tried to outrun fire.
None N. Carolina, 1968	1	Unknown	A county ranger was suppressing fire. Died of 3rd degree burns.
Ivey Florida, 1968	1	Heavy palmetto & wiregrass. Unexpected wind.	One-man suppression crew-tractor lodged on stump, and man couldn't escape.
None N. Carolina 1968	1	Unknown	Man, age 84, tried to beat fire with pine tops; clothes caught fire; was dead when found.
Eagle Rock Virginia, 1971	1	Reburn in rhododendron, steep slope.	Three men were felling snags and were trapped by fire.

OTHER AGENCY FATALITIES

NAME OF FIRE	NUMBER INVOLVED	FIRE BEHAVIOR	REMARKS
Banks Arkansas	1	Medium fuels, moderate winds, very high FDR.	Man was knocked unconscious by falling tree. He was fatally burned.
Harris Ridge Idaho, 1972	2	Steep, rocky terrain. Dry grass and brush and scattered trees. Thunderstorms caused "squirrelly winds."	Two men on fire line. A rolling log hit the men, and they rolled into the fire and died of suffocation.
Morgan Co. Tennessee, 1972 (Wartburg fire)	1	Small 24-acre fire. Wind gusts 20-25 mph. Fire crossed plowed line.	Plow operator trapped and suffocated on bench on upper side of fire.
Bell Valley California (CDF) 1973	1	Light brush. Weather clear & hot. Gently rolling topog.	Equipment Engineer & fireman working on flank of fire near gully. Man ran to road after flare-up,but died.
Stockton Utah, 1975	2	Sagebrush & grass, gentle to rolling topog. Wind changed direction.	Two county deputy sheriffs were working on flank of small fire when wind changed.
Battlement Creek Colorado (BLM) 1976	3	Rapid upslope fire on a steep draw with Southwest exposure on mixed mountain shrub type.	Four men were trapped on narrow fireline on ridge and three died.
Buhler Kansas 1976	1	Flash-over occurred from build-up of gases on lee side of the windbreak.	Fireman tried to outrun fire. Fire engine also burned.
Bass River New Jersey 1977	4	Fire was crowning and spotting in pine forest and crew trapped.	Volunteer Fire Chief & three were burned in hot fire.
Honda Canyon California (AFB) 1977	3	Fire was pushed downhill in light brush by Santa Ana winds.	Fire Chief, Ass't Fire Chief & Base Commander ran downhill to escape fire
Riverside Texas V.F.D. 1977	1	Fire in heavy grass with strong winds.	Man trapped between fire and truck, fell down and burned.
Lost Creek Slash Burn BLM(Oregon) 1978	1	Slash burning 15-acre Douglas fir clearcut block.	One man was trapped in burning operation and died.
Terrell County Georgia Forestry Commission 1978	1	Fire in pines and grass pushed by 17-mph wind.	Tractor-plow operator became confused in dense smoke and went into fire.
British Columbia Canada w/in last 5-years	1	Unknown	Unknown

OTHER AGENCY FATALITIES

NAME OF FIRE	NUMBER INVOLVED	FIRE BEHAVIOR	REMARKS
Okefenokee Prescribed Burn FWS, Florida 1979	1	Prescribed burn escaped and became a wildfire.	One man tractor operator was trapped when wind changed.
Saratoga Springs California CDF 1979	1	Fresh fireman on 10-acre brush fire in June.	Man either was overcome w/CO or had heat stroke.
Indian Ranch California CDF 1979	4	Crew of 5 on fire in light brush and wind changed.	Three were trapped at head of fire when backfiring.
SW Oregon 1979	1	Unknown	Reported in Aug.-Sept. 1979 Western Conservation Journal
Geraldton P-3/79 Ontario, Canada 1979	7	Prescribed burn behavior more severe than expected.	Seven young people were trapped.

Appendix C

NEAR-MISSES - ALL AGENCIES

Name of Fire, Agency, Year	Number Involved	Fire Behavior	Remarks
Milepost 324 Plumas NF 1949	One(Carl Wilson)	Fire made run in sagebrush and grass.	Wind shifted briefly, and fireboss ran back through burn to safety.
Horseshoe Basin, Gallatin NF 1953	Crew boss & 10 men	Unburned islands of subalpine fuels & small meadows. Unburned islands burned out when cumulus clouds developed over fire.	Fire was spotting all around men so they sat in pothole with water up to their necks while fire blew over.
Alder Creek Oregon 1955	One crew	Fireline being built in bottom of heavily-timbered canyon. Fire crossed canyon and surrounded crew.	Crew ran down canyon to edge of fire. One tractor burned up.
Sagebrush Cyclone Malheur NF 1955	One crew	Downdrafts from thunderstorm created strong winds on a sagebrush fire.	Experienced logger got separated from crew, and he tried to outrun fire uphill. Rest of crew went into burned area.
Satters Meadow Fire Payette NF 1957	Foreman & brush crew	Fire burning in spruce logging slash at 7,000 ft. elevation. Winds picked up and blew fire across line.	Foreman and crew had predetermined line of retreat to small meadow and elk wallow.
Lakeview Fremont NF 1958	Sector Boss & 25 men	Fresh logging slash and pine reproduction. Wind stopped and direction changed unexpectedly.	Sector boss and crew rushed back into burned area and suffered minor burns.
Woodwardia Angeles NF 1959	18	Fire was smouldering in canyon below helispot in light fuels.	Eighteen men dug in on lee side of helispot, and fire spotted overhead. Steep downhill situation without planned escape route.
Brushy Gulch Fire Salmon NF 1960's	Sector Team & 40 men	Fire burning in logging slash in steep canyon at night with up-canyon winds.	Sector boss and 5 men found safety at heliport as fire ran uphill - rest stayed on fireline.
Cottonwood Park Fire Medicine Bow NF 1960's	Crew Boss & 13 men	Fire was in mop-up stage. Temperatures rose, and unexpected winds blew fire across firelines - because of unburned fuels inside.	Crew scrambled to safety as fire burned 1,200 acres more.
Magpie Ridge Oregon 1960's	4 men	Main fire was contained, but it blew up and headed uphill toward crew on small spot fire on slope.	Crew ran toward ridge top but one man fell and had to be carried - made safe area with 5 minutes to spare.
Fire in Region 4 1960's	Two men	Fire had burned downhill on ground then crowned uphill toward men.	Men abandoned fireline in time to reach safety.

NEAR-MISSES - ALL AGENCIES

Name of Fire Agency, Year	Number Involved	Fire Behavior	Remarks
Country Lakes New Jersey 1963	Two men	Fire in brush and pines threatening homes & highway.	Crew had to abandon backfire and escape.
Oregon Protection Agency Fire, Ore. Prot. Agency 1960's	Crew Boss & 37 men	Daytime temperature was 105° and fire was burning in scrub oak and light brush at night. Unburned fuels inside perimeter caused spots across catline.	Crew moved to safety in time - while 200 acres more burned.
Tenus Gorge Fire Wenatchee NF 1961	Crew	Fire in heavy cheatgrass & scattered brush in breaks of Columbia River. Spotfire started below crew.	Crew burned out a "safety area" on a knoll. In a few minutes main fire passed, but no one was injured.
Salmon River Fire Payette NF 1961	Crew Boss & Pumper Crew	Fire burning in cheatgrass then crowned in brush & timber on steep slopes of Salmon River.	Fire jumped road, but crew moved back and forth on road to avoid being burned.
Fresno Co. Fire-Calif. Div. of Forestry 1962	4 men	Strong winds in light fuel (grain field). 90o temp. Wind shifted unexpectedly.	Fire outflanked 4-man pumper crew. 3 men found safety in truck cab. One man went to burnt out area.
River Bend Fire Deschutes NF 1962	Division Boss & Tractor Operator	Fire burning in open ponderosa pine and manazanita brush. Fire crowned in ponderosa pine.	Man ran uphill along dozer line and buried face in soil. Wind let up, and he escaped.
Magpie Fire Wallowa-Whitman (near Hells Canyon) NF 1963	Fire Boss & 20 men	Fire was in mop-up stage when there was a sudden increase in wind-blowing upslope. Fire burned in dense stand of grass.	Crew working downhill on steep slope in heavy, dry grass. Found safety in 30 ft. burned out strip on the ridge top.
Boot Strap Fire BLM,Elko District 1964	Foreman & inmate crew	Fast-moving fire in sagebrush and grass moving on wide front	Foreman was driving across front of fire with crew when they encountered end of fire & drove through safely.
Winter Rim Fremont NF 1966	Sector Boss & 50 men	Light gusty winds at night caused fire to jump line in reproduction patches.	Crew pulled out, and went to fire perimeter because of erratic behavior.
Payette Forest Fire Payette, NF 1967	6-man crew	Lodgepole pine blowdown. Gusty winds caused blow-up from cat piles.	Three men found safety in clearing, and 3 went into burn. No one hurt.
Corn Creek Salmon 1961	16-man crew	Lodgepole pine on north & Ponderosa-grass on S. slopes.	Entire crew was trapped when fire blew up in canyon bottom.

NEAR-MISSES - ALL AGENCIES

Name of Fire Agency, Year	Number Involved	Fire Behavior	Remarks
Ginnis Lake Wisconsin DNR, 1967	One man	Red pine plantations and oak near a lake.	One man on tractor with plow was on spot fire ahead of main fire and was caught by main fire.
Fourth of July Mt. Fire Wenatchee NF 1967	Foreman & crew	Fire in light fuels was quiet in early morning (2:00-3:00 a.m.) then humidity unexpectedly dropped & entire canyon burned out.	All men were pulled into safety zone.
Evergreen Mountain Rogue River NF 1967	Crew foreman & crew	Firebrands from a clear-cut area rolled downhill below crew. Fire fishhooked up slope during mid-day.	Crew foreman and crew ran to the clear-cut burned area for safety and had to stay six hours.
Indigo Siskiyou NF 1967	1	Fire in Douglas-fir reproduction and in clear-cut block. Fire crowned in reproduction and blocked line of retreat.	Scout ran down cat line between fire in cut-block and flare-up in Douglas-fir reproduction, but was not injured
Slash Colville NF 1967	Scout	Reburn below saddle in 250-acre cut-block blew through saddle.	Ran downhill through fire in saddle and got second & third degree burns on face, neck and hands.
Alaska Interior Bureau of Land Mgmt. Territory 1968	25 men	Temperatures continued high at night because sun didn't set. Flareup in peat bogs surrounded crew.	Line was abandoned and men moved into a swamp, waist-deep in water. Fire burned in grasses covering swamp,. but no one was burned.
Canyon Angeles NF 1968	3 tanker crews	Backfire operation triggered flareup of main fire in canyon below men at night. Tankers surrounded by unburned fuels.	Banker crews retreated to burned out area near powerline and waited out the flareup.
Laguna Cleveland NF 1970	75 men, 2 tractors & 4 tankers	Fuels were grass and brush. Wind from E-NE 40 mph. Spotfire outside of line "blew up." About 40 acres "exploded."	All men ran for cat line and semi-burned area. Nobody hurt, but all hac singed hair and eyebrows.
Mitchell Creek Fire Wenatchee NF 1970	Line boss and crews	Unexpected strong upslope winds at midnight caused fire to jump line.	Crews were pulled out in time.
South Tommy Fire Wenatchee NF 1970	Crew	Fire spotted below crew and came "roaring up mountain." Weather hot, dry and windy.	Crew in unfamiliar country found refuge in burned-over rock slide for two nights.

NEAR-MISSES - ALL AGENCIES

Name of Fire Agency, Year	Number Involved	Fire Behavior	Remarks
East Line Road Myles Standish State Forest Mass., 1971	8 men	165-acre fire burning in pine oak fuels in sandy, hilly terrain and a bog.	Frontal passage caused fire to blow-up and trap 8 men. 4 badly burned.
Meyers Fire San Bernardino NF 1970	Sector Boss & crews	Fire burning in steep country and dense chaparral at night and spotted across line.	Crews and cats were building line downhill when fire blew-up - they found safety in cat line.
Freezeout Oregon 1973	60 - 70	Fire came up slope at night into grass-covered area.	Crew pulled away from edge of canyon into safety area. Crew isolated from camp for 3 hours.
7th Avenue New Jersey 1973	Two men	Fire in brush & pines near Port Elizabeth.	In effort to control the backfire both the men were burned.
Friendship Wisconsin DNR Volunteers 1976	2+ men	Drove military 6 x 6 (converted) ahead of fire in heavy jack pine.	Crew had to escape after truck stuck in heavy cover.
New Minor Wisc. DNR Volunteer FD 1976	2+ men	Crew tried to make stand on road at head of fire in jack pine.	Truck damaged but men survived.
Necedah Wisconsin DNR 1977	One man	Five in mixed jack pine and oak.	Tractor operator tried to cut off head of fire, but failed.
Long Bay Apalchicola NF and Florida DNR 1977	2 men	Fire in heavy Ti Ti at edge of swamp & wind shifted.	Tractor-plow stalled and men escaped after main fire hit them.
Dead Wilma BLM, Oregon 1977	2 men	Fire in pine & grass on relatively gentle slopes, but wind changed.	Men were on pumper which got stuck when wind changed. Both escaped.
Morrison Reservoir Prescribed Burn BLM Oregon 1979	2 persons	Sage-grass burning a control line around a control burn, but it jumped line.	Fire truck got stuck & burned. Crew escaped.
Bryant Mt., BLM Oregon 1979 (Worlow Fire)	19 person crew and Crew Boss	Ponderosa pine. Eastern Oregon. Wind shifted.	Crew went to a meadow and deployed in fire shelters.

NEAR-MISSES - ALL AGENCIES

Name of Fire Agency, Year	Number Involved	Fire Behavior	Remarks
Oscoda Prescribed Burn-38+acres Michigan 1979	One man	Prescribed fire escaped in jack pine slash.	Skidder plow stalled and operator ran to safety.
Flat Fire BLM, Idaho	4 men	Fire in sage-grass, and wind shifted.	Fire ran into lead tanker and engine died. One man injured.
SW Oregon 1979	"Several"	Unknown	Reported in Aug.-Sept., 1979 Western Conservation Journal
Ontario,Canada 1979	3	Unknown	Unknown
Alberta,Canada 1979	2	Unknown	Unknown
North West Territories, Canada 1979	2	Unknown	Unknown

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Appendix E

Table of Organizations Responding to Fatal/Near-Fatal Task Force's Requests for Information.

State Foresters

Arkansas
California
Colorado
Delaware
Florida
Georgia
Hawaii
Iowa
Kansas
Louisiana
Maryland
Michigan
Missouri
Nebraska
New Hampshire
New Jersey
New York
North Carolina
Tennessee
Texas
Wisconsin

Department of the Interior
BLM State & Organizations

Alaska
Arizona
California
Colorado
Idaho
Nevada
New Mexico
Oregon
BIFC
Washington Office

U.S. Fish & Wildlife Service

Department of Agriculture
U.S. Forest Service

Canada

British Columbia

☆ U. S. GOVERNMENT PRINTING OFFICE : 1980—338-722