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Technical Report 844

# Fire Fighting as Extended Operations: The Yellowstone Experience

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Donald B. Headley  
U.S. Army Research Institute

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respondents. Some responses differed as a function of location of questionnaire administration. Data from this kind of mission appear to be useful for application to extended operations. The similarities are the stressful nature, physical demands, and the "quick reaction" status that mimic true deployment. The potential also exists for gathering information on the influences of leadership, rank, and other aspects of the scenario that affect morale and motivation, and hence, performance and endurance. (S) 11

**Technical Report 844**

**Fire Fighting as Extended Operations:  
The Yellowstone Experience**

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## FOREWORD

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Because technology has provided military equipment with around-the-clock, all-weather capability, military leaders need to determine what levels of performance individuals and units can produce for sustained periods of time.

A potentially useful opportunity for data on this topic arose during August and September 1988, when active duty soldiers were deployed to Yellowstone National Park to provide fire line support to the U.S. Forest Service.

The U.S. Army Research Institute for the Behavioral and Social Sciences was asked by the U.S. Army Concepts Analysis Agency (CAA) to develop and administer a questionnaire for the fire fighting soldiers. This questionnaire was designed to measure attitudes toward the experience and to assess the effects of fatigue on performance. If data on stress and performance from a natural disaster were an approximation of combat, such occurrences could be used as a viable source of performance data for combat analysis.

The research team functioned under the approval of the Office of the Deputy Chief of Staff for Operations. Results in this report were briefed to the Director, CAA, on 17 February 1989. This research furthers ARI's programs that seek to maximize the soldier's effectiveness on the battlefield.



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The author is especially grateful for the field leadership and assistance provided to the team by its military leader, Colonel Daniel Redmond of the Neuropsychiatry Division, Walter Reed Army Institute of Research.

# FIRE FIGHTING AS EXTENDED OPERATIONS: THE YELLOWSTONE EXPERIENCE

## EXECUTIVE SUMMARY

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### Requirement:

Active duty soldiers provided direct fire line support for the Yellowstone National Park fires of 1988. The mission provided a data collection opportunity to determine if such noncombat scenarios could serve as a source of information on stress and performance in extended operations.

### Procedure:

A 45-item questionnaire was developed and administered to 1,000 soldiers who were on site at Yellowstone or who had returned to their home station. The focus of the questionnaire was performance and stamina for physical work in this unique environment.

### Findings:

Most of the respondents rated their fire line duties as more taxing than those in field training exercises. Sixty percent felt their ability to engage in continuously long, physically demanding workdays decreased over time; the median point of perceived decline in capability was estimated at 5 days. Other factors identified as having an influence on performance were perceived importance of duties, a lack of organization, and unclear expectations concerning the length of the mission. Response patterns were affected by rank of the respondents. Some responses differed as a function of location of questionnaire administration.

### Utilization of Findings:

Data from this kind of mission appear to be useful for application to extended operations. The similarities are the stressful nature, physical demands, and "quick reaction" status that mimic true deployment. The potential also exists for gathering information on the influences of leadership, rank, and other aspects of the scenario that affect morale and motivation, and hence, performance and endurance.

FIRE FIGHTING AS EXTENDED OPERATIONS: THE YELLOWSTONE EXPERIENCE

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## FIRE FIGHTING AS EXTENDED OPERATIONS:

### THE YELLOWSTONE EXPERIENCE

#### BACKGROUND

Typical battlefield stresses include fear of injury, death, or capture, difficult terrain and climatic conditions, noise, night fighting, encapsulation (e.g., buttoned-up tank; chemical protective ensemble), extended operations, and fatigue. During the months of August and September, 1988, soldiers from the 9th Infantry Division (Motorized) of Fort Lewis, Washington, experienced many of these stressors in a different context. The "battlefield" was Yellowstone National Park and the "enemy" was the series of forest fires that had become so widespread in the Park that the Boise Interagency Fire Center requested the support of active duty soldiers. In addition to the fire per se, the soldiers had to deal with long workdays, steep terrain, adjustment to a high altitude environment, thick smoke, strong winds, falling trees, and wide-ranging ambient temperatures.

Rapid deployment, quick acclimation, and sustained performance are necessary capabilities for successful battlefield operations. Because these qualities also appeared to be essential for the Yellowstone mission, a survey team was formed at the request of the U.S. Army Concepts Analysis Agency (CAA) to collect information related to extended operations. If data on stress and performance from a natural disaster situation were an approximation of the combat scenario, such occurrences could be used as a viable source of performance data for combat models.

Forest fire fighting offers an opportunity to study the effects of fatigue on performance. The US Forest Service has an ongoing program dealing with the effects of extended fireline shifts. Their concern is that "such long shifts fail to provide adequate rest/recovery time for line personnel, resulting in excessive fatigue. This fatigue can result in injury to health, unclear thinking, poor fire management, and loss of production" (U.S. Forest Service, 1984, p. 1).

#### METHODS

##### The Survey Team, the Questionnaires, and their Administration

Organizations represented in the team were CAA, Walter Reed Army Institute of Research, U.S. Army Human Engineering Laboratory (HEL), and the U.S. Army Research Institute for the Behavioral and Social Sciences (ARI). Six members from these agencies traveled to the Yellowstone area in late September to administer questionnaires to the soldiers who were still on site and then went to Fort Lewis to gather data from those soldiers who had returned to their home station. The team functioned under the approval of the Office of the Deputy Chief of Staff for Operations.

HEL and ARI each prepared a questionnaire. The focus of the HEL questionnaire was on obtaining quantitative and qualitative measures of the stress perceived by the fire crews. Results of this questionnaire are

available in a separate HEL report (Fatkin, King, & Hudgens, 1989). The 45-item ARI questionnaire was designed to measure soldiers' attitudes toward the experience and their own assessments of fatigue and performance. The items were categorized as follows: biographical and unit identification data, 6 items; previous experience in long workdays, 4 items; preparation and training for the Yellowstone mission, 9 items; and fire line activities, 26 items.

Questionnaires were administered in group fashion in the lobby of a lodge at Yellowstone, the Montana State University Fieldhouse (soldiers of one battalion were temporarily housed here while awaiting redeployment), a hotel conference room, a hotel basement, and the Fort Lewis Post Theater. At each location approximately one half of the assembled group completed the ARI questionnaire before the one from HEL and vice versa. Soldiers were informed that their participation was strictly voluntary, and that full confidentiality of responses would be maintained. They were asked to place their signature and social security number on the volunteer agreement page of each questionnaire. The completion of both questionnaires took about 45 minutes.

## RESULTS

### Responses, Grouping of Records, and Analysis Procedures

Of those soldiers who were handed a questionnaire, approximately 95 per cent returned one to the team. The pool of returned questionnaires totaled 1116. Eighty-two per cent of them contained both a signature and a social security number.

Ninety-three percent of the respondents belonged to the five ground task forces (GTF), six per cent to aviation assets, and one per cent to the Joint Task Force Tactical Operations Center. The questionnaire was designed mainly for the GTF and these units will be the focus of this report. The 1,039 GTF records represent a 48 per cent sampling of the 2,171 GTF soldiers who participated at Yellowstone (not all soldiers were available at the time of the team's arrival at each location). Thirty-one per cent of the GTF records were collected from soldiers in or around the Yellowstone area.

For purposes of analysis, records were grouped by GTF. Assignment of records from each of 23 identified companies or batteries to a GTF was based on information from the Department of Defense Joint Task Force Yellowstone After Action Review (DOD JTF AAR; Dept. of Defense, 1988). Two of these 23 units served on two different GTFs; they were grouped with their second affiliation (another battalion which had operational control of them) which represented the majority of their time at Yellowstone. Those records which were missing a unit identification ( $N = 123$ ) could not be assigned to a GTF, but were included in those analyses which did not categorize the records by GTF. The GTFs were coded A through E to honor the commitment of confidentiality of responses.

Because the interest of this study is on those soldiers whose main duties were oriented towards fire fighting duties per se, the majority of analyses were performed on the 830 records corresponding to the GTF enlisted soldiers' responses. A distribution by rank is shown in Table 1.

TABLE 1

Distribution of Number of Records by Rank and Ground Task Force (GTF)

GTF	Rank					Totals
	E1-E4	E5-E8	O1-O5	W01-W03	Unknown	
C	103	40	6	0	6	155
E	153	66	37	0	21	277
A	96	23	11	0	3	133
D	57	17	10	0	2	86
B	125	70	21	4	10	230
Unknown	54	26	4	1	38	123
Totals	588	242	89	5	80	1004

Notes: Twenty-two records were removed from the GTF set because of incomplete responding, and 13 were removed because the respondents indicated they engaged in other than fire fighting type duties (i.e., served primarily in a field tactical operations center or as a medic); 14 records were obtained from the Joint Task Force Tactical Operations Center, and 63 were obtained from aviation assests (these 77 records are not included in the analyses of this report).

Responses were coded, entered into a computer, and analyzed by the Statistical Analysis System (SAS) software package (SAS Institute Inc., 1979, 1982). Categorical variables were formed into contingency tables and tested for statistical significance by the chi square test. Because the continuous measures represented respondents' judgments and estimations, the distributions were first tested for skewness. If significantly skewed, group differences were assessed by the median test (Conover, 1971). Otherwise, non-skewed data sets were tested by the unpaired t test or one-way analysis of variance. Differences reported as statistically significant had a probability level of .05 or less. The statistical information (test statistic, degrees of freedom (df), and probability level) for tests reported is included in the footnotes of the applicable data tables. All respondent judgment and estimation items are presented as integers (i.e., no decimal-level precision is implied).

#### Summary Details of Tour: Deployment, Training, Chain of Command, and Duties

Actual number of days on official fire line duty for the GTFs was 23-24. Units were alerted during the period 19-26 August and deployed during 22-29 August. Before deploying, soldiers attended a one-day, on-post Basic Fire Fighting Course conducted by Forest Service personnel. Deployment consisted of a 1.5-2 hour airplane ride from the Fort Lewis area to the Yellowstone area followed by a 4-5 hour bus ride to the base camp area. The units then received further fire fighting training in the form of equipment use and practice on fire break and mop up techniques.

Military and Forest Service personnel coordinated efforts at all levels. A Brigadier General was in charge of the DOD JTF Yellowstone, and worked in the Area Command Center with supervisors from the National Park Service and Forest Service. The command structure from the Task Force level and lower is described in Appendix A.

A typical day for the soldier-fire fighter began with a wake up call around 0530, followed by breakfast and transportation to the fire site. Reaching the work area was accomplished by bus, helicopter, foot, or some combination thereof. Travel time depended on accessibility of the site; air transportation typically took between 10 to 20 minutes, a bus ride from .5 to 2 hours, and hiking from 1 to 3 hours. Between 1700-1900 the units would be returned to their camp and a hot meal would be served. "Lights out" was around 2200. More details are provided in Appendix B.

Respondents were asked to list their fire area tasks and the equipment they used ("What kinds of duties did you have in the fire area on a typical shift?"; "What kinds of equipment did you use in the fire area on a typical shift?"). A breakdown of the more frequently stated activities by GTFs is shown in Table 2. An average of 2.8 activities was listed per questionnaire. Cutting firebreaks and mop up operations were predominant tasks, comprising 57 per cent of all activities listed. A notable exception to line work as the most frequent activity is GTF E, which listed that activity only 22 per cent of the time, the difference being attributed to an increase in citations of "fuel reduction" type work (see footnote in Table 2 for description of term). Although the majority of activities involved work which could be construed as hard, dirty, and sometimes boring some units did have close contact with active fires per se, at times providing fire suppression work on "hot lines"

TABLE 2

Breakdown (Per Cent) of Most Frequently Stated Fire Line Activities by Enlisted Soldiers

Activity	Ground Task Force					All
	C	E	A	D	B	
Cutting Fire Breaks <sup>a</sup>	35	35	32	32	22	33
Mop Up <sup>b</sup>	26	25	24	24	30	24
Back Fires	4	8	16	16	4	8
Cutting Snags & Branches <sup>c</sup>	12	7	5	6	6	7
Hose rolling, Unrolling	13	5	9	9	6	8
Fuel Reduction <sup>d</sup>	3	3	6	2	21	6
Others	7	17	8	11	11	13
Number of Activities Cited	352	591	330	198	654	2301 <sup>e</sup>

<sup>a</sup>

This term was used to include the general fire line activities involved in building, improving, and maintaining lines for the purpose of containing a fire's progress.

<sup>b</sup>

Mop up activities were performed in areas burned over by fire (although hot spots and spot fires were probable), and included spraying and ground-tool work.

<sup>c</sup>

Snags, or "leaners", are burned out trees which can fall without warning.

<sup>d</sup>

Fuel reduction is a Forest Service term for clearing areas of logs and brush. This work included burning brush piles and stacking wood. On occasion, soldiers referred to these duties as "park beautification" and perceived it as "busy work" (underutilization) and not within their mission.

<sup>e</sup>

The "All" data set includes records with unknown Task Force identification. This total is therefore greater than the sum of the individual Task Forces.

and structural protection of buildings inside the park's boundaries and on its periphery. A daily listing of GTF activities and missions is provided in the logs contained in Appendix 2 of the DOD JTF AAR (Dept. of Defense, 1988).

Table 3 shows the most frequently cited pieces of equipment. An average of 3.0 items were listed per questionnaire. The six items shown clearly benefit fire line and mop operations. Earthing tools comprised 79 per cent of the listings: shovel, pulaski (axe), McLeod (rake), and Combi tool (combination hoe, pick, & shovel).

### Soldier Conditioning and Fire Fighting

Soldiers were from infantry, field artillery, air defense artillery, engineering, and aviation units. Their Yellowstone experience represented essentially 3.5 weeks of long workdays (with occasional time for stand down and R&R). Mop up operations and cutting firebreaks under conditions of smoke, steep terrain, and changing temperature conditions would be construed by most as hard work. Soldiers' year-round requirement for fitness, and previous training experiences should allow them somewhat easy adaptation to this unusual battlefield. Such a "can-do" attitude is shown in comments by soldiers to the press during their Yellowstone experience (see Appendix C).

Previous experience and perceived stamina. Most of the respondents had previous experience with long workdays. To the question, "Have you participated in 24 hour or longer mission assignments either in combat or training exercises in which you got only a few hours sleep each night?", 88 per cent responded "Yes" (Table 4). The lengths of the extended operations are shown in the lower portion of the table.

Perceived stamina was assessed by the question, "How many hours do you feel you can remain awake and still maintain operational effectiveness for physical type duties?". An average value of 32 hours, and a median of 24 hours were estimated (Table 5); the estimates across GTFs were not statistically different from each other.

A negative relationship was found between experience as measured by length of the extended operation, and perceived stamina: the longer one's previous mission the shorter the stamina estimate (Table 6). Specifically, those whose longest extended operation was 4 days (the median) or less estimated a perceived stamina of 30 hours (median), versus 24 hours for those whose longest mission was greater than 4 days.

Fatigue status at start of duties. An attempt was made to assess the soldiers' state when they began their formal fire fighting duties. The alert, preparation for and the act of deployment, and cold-line training (i.e., practice in areas burned over by fires) may have put the soldiers in an exhausted state before they began operations.

Twenty-two per cent reported that they felt "Rested," 52 per cent responded "Somewhat Tired," and 26 per cent felt "Very Tired" (Table 7). This pattern was similar across the GTFs. Although this item was intended to gauge their state on Day 1 of fire fighting per se, some respondents apparently made their judgments based on the general experience, in spite of the questions's placement in a section labeled "Preparation and Training for

TABLE 3

Breakdown (Per Cent) of Most Frequently Stated Equipment used in Fire Area by Enlisted Soldiers

Equipment	Ground Task Force					All
	A	B	C	D	E	
Shovel	29	34	28	26	28	30
Pulaski	25	31	25	22	27	27
McLeod	15	21	19	20	16	18
Combi Tool	0	1	0	9	11	4
Back Pump	12	7	14	8	8	9
Chain Saw	10	2	5	3	5	5
Others	9	4	9	12	5	7
Total Pieces of Equipment	426	564	401	225	672	2522 <sup>a</sup>

<sup>a</sup>

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

TABLE 4

## Previous Experience in Extended Operations, Enlisted Soldiers

Item	Ground Task Force					All
	A	B	C	D	E	
Military Experience in Long Workdays? <sup>a</sup>						
% Yes	86	91	92	93	83	88 <sup>b</sup>
Total N of Records	140	217	117	73	194	816
Longest Continuous Mission, Days <sup>c</sup>						
Average (rounded)	11	13	13	11	13	12
Standard Deviation	14	19	16	13	17	17
Median <sup>d</sup>	3.8	3	5	4	5	4 <sup>b</sup>
Total N of Records	115	188	101	66	153	687

a

Test of response pattern differences among the Task Forces was significant (chi square = 10.6, df = 4, p < .05).

b

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

c

A value greater than 182 days was arbitrarily declared an outlier; this procedure resulted in one record deleted from the analysis.

d

Median test for Task Force differences was not significant (chi square = 6.0, df = 4, p < .25).

TABLE 5

Perceived Stamina (hours), Enlisted Soldiers, by Ground Task Force

Item	Ground Task Force					All
	A	B	C	D	E	
Mean	30	35	32	32	32	32
Std. Dev.	19	19	18	17	19	19
Median <sup>a</sup>	20	24	24	24	24	24 <sup>b,c</sup>
N of Records	117	190	106	62	181	729

Note. Officers' mean = 39, std. dev. = 18, median = 36.

a

Median test for Task Force differences was not significant (chi square = 6.6, df = 4,  $p < .25$ ).

b

A value less than 12 or greater than 120 hours was arbitrarily declared an outlier; this procedure resulted in 53 records deleted from the analysis.

c

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

TABLE 6

## Relationships between Selected Variables

Variable 1	Variable 2	Values	Statistical Test Results
Longest Continuous Mission	Perceived Stamina	-.10	Spearman correlation coefficient, n = 612, p < .01
Fatigue Status at Start of Duties	Perceived Stamina		
Rested	Median values of Variable 2 blocked by Variable 1 categories:	24	Median test chi square < 1, df = 2
Somewhat Tired		24	
Very Tired		24	
Fire Fighting Physically Harder than FTX Tasks?	Fire Fighting Mentally Harder than FTX Tasks?		
Yes	Yes	45	
	No	55	
		-----	
		100%	Chi square = 24.2, df = 1, p < .001
No	No	82	
	Yes	18	
		-----	
		100%	
Fire Fighting Physically Harder than FTX Tasks?	Fatigue Status at Start of Duties		
Yes	Rested	19	
	Somewhat Tired	52	
	Very Tired	29	
		-----	
		100%	Chi square = 24.8, df = 2, p < .001
No	Rested	38	
	Somewhat Tired	52	
	Very Tired	10	
		-----	
		100%	

TABLE 6, cont.

Relationships between Selected Variables

Variable 1	Variable 2	Values	Statistical Test Results
Fire Fighting Physically Harder than FTX Tasks?	Weight Change		
Yes	Average values of Variable 2 blocked by Variable 1 categories:	-6	$t = 4.5, df = 732, p < .001$
No		-3	
Ability to do Work Decrease over Time?	Fatigue Status at Start of Duties		
Yes	Rested	16	$\chi^2 = 40.6, df = 2, p < .001$
	Somewhat Tired	50	
	Very Tired	34	
		----- 100%	
No	Rested	30	
	Somewhat Tired	55	
	Very Tired	15	
		----- 100%	
Fatigue Status at Start of Duties	When did you Ability to do Physical Work Decrease?		
Rested	Median values of Variable 2 blocked by Variable 1 categories:	8	Median test $\chi^2 = 12.4, df = 2, p < .005$
Somewhat Tired		6	
Very Tired		4	

Note. Analyses were performed on overall data set of enlisted records. Analyses are listed in order of discussion in the text. Abbreviations: FTX = field training exercise.

TABLE 7

## Fatigue Status at Start of Fire Duties, Enlisted Soldiers

Category <sup>a</sup>	Ground Task Force					All
	A	B	C	D	E	
% Rested	22	22	25	22	18	22
% Somewhat Tired	46	53	50	52	59	52
% Very Tired	31	26	25	26	23	26
N of Responses	140	211	118	72	192	808 <sup>b</sup>

a

Test of response pattern differences among the Task Forces was not significant (chi square = 6.9, df = 8,  $p < .75$ ).

b

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

your Fire Fighting Duties." A number of write-in comments specified that mode of travel to the fire location determined their fatigue state at the beginning of the actual fire fighting for that day: the longer the hike and the steeper the terrain, the more tired they felt.

To test the hypothesis of a relationship between perceived stamina (subsection above) and fatigue status at beginning of duties, a test was run with the "start status" variable as the grouping variable (3 categories) and stamina as the dependent variable. However, estimated stamina (median) was independent of how one felt at the start (values listed in Table 6).

#### Extended Workdays and Fatigue

Comparison of duties to FTX. Respondents were asked to rate their fire fighting duties as being either physically harder or not as hard as their usual MOS tasks during a field training exercise. Eighty-seven per cent selected "Harder" (Table 8); the range of this response by GTF was 76 to 97. However, when asked to rate their fire duties as being mentally harder or not as hard, only 41 per cent chose the former response (Table 8). As based upon respondent comments, mental fatigue was attributed to the monotonous (boring) aspects of the duties, waiting-around periods, and lack of sleep.

If a soldier answered "Harder" to the physical question, he was approximately equally likely to respond "Harder" or "Not as Hard" to the mental question (Table 6), but if he answered "Not as Hard" to the former question, he was likely to answer "Not as Hard" to the mental question.

A trend is evident between responses to the physically harder-not as hard question and responses to the question concerning fatigue state at the start of fire duties: of those who responded "Harder," 81 per cent rated themselves as either "Somewhat Tired" or "Very Tired" versus 62 per cent of those who responded "Not as Hard" (Table 6).

Work decrease over time. Sixty per cent of the respondents said "Yes" to the question "Do you feel that your ability to do work decreased as the number of days on this job increased?" (Table 9). GFT differences in responding occurred; per cents "Yes" by GTF ranged from 44 to 75.

Respondents were asked to check from a list of six reasons why they felt the decrease occurred. The bottom panel of Table 9 shows that four reasons accounted for 92 per cent of the checks. The more frequently checked reasons involved hard work and long work days.

Items on the check list concerning inadequate supply of food and water accounted for only five per cent of the checks. Although food supplied by the Forest Service was plentiful, respondents estimated an average weight change of -6 pounds (Table 10; "How much weight, if any, do you think you lost during your fire fighting duty?"). Average estimated weight change was higher for those who answered "harder" to the question comparing the physical nature of fire fighting tasks to FTX tasks (-6 vs. -3 lbs.; Table 6).

Responses to the work-decrease question were cross tabulated with responses to the question concerning fatigue state at the start. Of those who responded "Yes", more rated themselves as either somewhat or very tired

TABLE 8

Comparison of Physical and Mental Qualities of Fire Fighting to Field Training Exercises, Enlisted Soldiers

Question	Ground Task Force					All
	A	B	C	D	E	
Fire Fighting <sup>a</sup> Physically Harder?						
% Yes	86	76	95	80	97	87 <sup>b</sup>
Total N of Responses	135	200	111	74	194	791
Fire Fighting <sup>c</sup> Mentally Harder?						
% Yes	55	29	38	24	47	41 <sup>b</sup>
Total N of Responses	125	202	110	72	188	773

<sup>a</sup> Test of response pattern differences among the Task Forces was significant (chi square = 49.8, df = 4, p < .001).

<sup>b</sup> The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

<sup>c</sup> Test of response pattern differences among the Task Forces was significant (chi square = 34.1, df = 4, p < .001).

TABLE 9

## Work Decrease over Time, Enlisted Soldiers

Item	Ground Task Force					All
	C	E	A	D	B	
Ability to do Work a Decrease over Time?						
% Yes	75	58	65	44	53	60 <sup>b</sup>
Total N of Records	135	211	115	72	192	802

Note. Officers' % Yes = 49.

a

Test of response pattern differences among the Task Forces was significant (chi square = 25.4, df = 4,  $p < .001$ ).

b

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

Reasons for the Decrease	Per Cent
"The type of work I did wore me out"	38
"Lack of sleep affected my physical stamina"	24
"There weren't enough rest periods"	17
"Lack of sleep affected my ability to think clearly"	13
<sup>c</sup> Others	8

Note: Total number of reasons given by those who answered "Yes" to the question (top panel) was 927. The average number of reasons listed was 2.0 (this value does not include 23 records which had a "Yes" response but no reasons checked).

c

Two other items on the check list were "I didn't get enough food"; "I didn't get enough water." These items accounted for 5 per cent of the checks. Write-in comments accounted for the other 5 per cent of the reasons.

TABLE 10

## Estimated Weight Change, Enlisted Soldiers

Measure	Ground Task Force					All
	A	B	C	D	E	
Change (pounds)						
<sup>a</sup> Average	-6	-4	-5	-5	-7	-6
Standard Deviation	6	6	5	6	5	6
Median	-5	-4	-4	-5	-7.5	-5
N of Records	129	197	111	71	190	770 <sup>b</sup>
% Who Indicated a Loss	67	54	57	61	83	66
% Who Indicated a Gain	0	5	1	1	1	2
% Who Indicated No Change	33	41	42	38	16	32

<sup>a</sup>

Test for Task Force differences was significant ( $F = 9.0$ ,  $df = 4$ ,  $695$ ,  $p < .001$ ).

<sup>b</sup>

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

(84 per cent) versus 70 per cent of those who said "No" (Table 6).

Respondents estimated a decrease in performance after a median stay of 5 days (average = 7) on the job (Table 11). The question was "After how many hours or days in the fire area did you first start to get tired to the point that your physical work was affected?". Median estimates differed as a function of GTFs, whose values ranged from 4 to 7. Variation within all GTFs was high, possibly a function of the intensity of work effort of their initial fire line duties. For example, some units found themselves on long hikes, steep terrain, and cutting fire breaks early in their missions, whereas others were initially placed on more relatively sedate mop up duties. A potentially useful question for a future questionnaire might be a ranking of perceived work intensity for such activities as hiking, working on steep terrain, cutting fire breaks, mopping up, using a chain saw, working with hoses, and so forth.

Estimated time to a decrease in physical work performance was related to fatigue status at the start of duties: those who indicated they were rested estimated a decrease after 8 days (median), those somewhat tired, 6 days, and those very tired, 4 days (Table 6).

#### Danger

Respondents were asked "Did you ever feel your personal safety was threatened by the fire?" Fifty-five per cent stated "Yes" (Table 12). The nature of write-in comments for this item indicated that the question was interpreted by some to mean a broader context than the fire per se, that is, it included fire area and fire environment as well: flare-ups, thick smoke, unseen hot spots, and "walls of fire" (tall burning trees) were cited as dangerous, as were equipment (axes, chain saws), snags ("widow makers"--burned out trees which fall without warning), steep terrain, rolling boulders, and fatigue (Another safety item on the questionnaire was "Did you or any of your crew members become so tired that you became a danger to yourselves?"; 29 per cent responded "Yes.").

According to the DOD JTF After Action Review (AAR), no major injuries were sustained by the soldiers. Of the some 1,800 cases treated in on-site medical units, 24 per cent were for "musculoskeletal injuries including sprains, strain of muscles, ligaments and tendons and soft tissue injuries"; 19 per cent were "respiratory including colds, URIs, smoke related pharyngitis, bronchitis"; 16 per cent were "ENT to include sinusitis, congestion"; 13 per cent were "dermatology including cellulitis and minor burns"; and 20 per cent were "other including podiatry, G/U, viral syndrome" (Dept. of Defense, 1988, p. 1-29).

#### Morale Issues

Perceived leadership. This mission was unique not only because of the different kind of "battlefield" but also because of the multi-structural chain of command which linked military personnel with the Forest Service. The military fire fighters were asked for their perspective on overall organization by responding to the question: "Were the activities of your group well organized by your supervisor?". Fifty-two per cent of the enlisted personnel responded "No" (Table 13), versus 33 per cent for the officers. The

TABLE 11

Estimated Time (days) of Decrease in Physical Performance, Enlisted Soldiers,  
by Ground Task Force

Item	Ground Task Force					All
	A	B	C	D	E	
Mean	8	7	8	7	6	7
Std. Dev.	6	6	7	6	6	6
<sup>a</sup> Median	7	5	5	5	4	5
N of Records	95	135	77	47	135	543 <sup>b</sup>

Note. Officers' mean = 7, std. dev = 6, median = 7

<sup>a</sup>

Median test for Task Force differences was significant (chi square = 14.3, df = 4,  $p < .01$ ).

<sup>b</sup>

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

TABLE 12

## Perception of Danger by Fire, Enlisted Soldiers

Safety Threatened? <sup>a</sup>	Ground Task Force					All
	A	B	C	D	E	
% Yes	64	49	62	53	46	55
Total N of Records	137	213	118	72	195	812 <sup>b</sup>

a

Test of response pattern differences among the Task Forces was significant (chi square = 15.4, df = 4, p < .005).

b

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

TABLE 13

## Enlisted Soldiers' Perception of Organization of Activities by Supervisors

Activities Organized? <sup>a</sup>	Ground Task Force					All
	A	B	C	D	E	
% No	39	67	38	57	53	52
Total N of Records	131	202	107	69	182	763 <sup>b</sup>

Note: Officers' % No = 33.

a

Test of response pattern differences among the Task Forces was significant (chi square = 34.1, df = 4, p < .001).

b

The "All" data set includes records with unknown Task Force identification; this total is therefore greater than the sum of the individual Task Forces.

range of "No" responses as a function of GTF varied from 38 to 67 per cent.

This questionnaire item generated a number of write-in comments. Those that could be categorized were placed under three main headings: chain of command problems (24 comments); lack of feedback, poor communications, or inconsistent plans (11); and inactivity or poor useage of time (5). Those comments of substance are presented in Table 14.

Other negative aspects. General write-in comments, or comments to other questionnaire items identified additional aspects of the deployment which troubled the soldiers. They expressed concerns over working side-by-side with highly paid civilian fire fighters in the face of uncertainties over ration pay and hazard pay. Also, continued discrepancies in the stated length of stay in the Yellowstone area (which changed from 10, to 14, to 21, then 30 days) caused morale to be lowered, as did uncertainties concerning when the first R&R day(s) would occur.

#### The Influence of Rank on Responses

The previous items were reanalyzed as a function of rank of the respondent. For purposes of analysis, rank was dichotomized into the groups E1-E4 and E5-E8, which were cross tabulated with other categorical responses, and used as the blocking variable for continuous measures. The results are summarized in Table 15. The higher ranking enlisted soldiers were less likely to be negative towards their supervisors. Additionally, patterns differed for their responses concerning long workdays: more of the higher ranking personnel had experience in extended operations, gave a higher estimate of perceived stamina, and showed a lower tendency to judge that their ability to do physical work decreased over time. It may be noticed that the values given by officers (see Note section of Tables 6, 10, & 12) for the items pertaining to perceived stamina (median hrs.), work decrease over time (% Yes), and point in time when ability to do work decreased (median days) were all equal to those of the high-rank enlisted group's.

#### The Influence of Location of Questionnaire Administration on Responses

Because of the research team's late arrival on the scene, only 22 per cent of all the GTF questionnaires were administered on-site at Yellowstone, and an additional 8 per cent was obtained from troops awaiting redeployment at Bozeman, MT. The bulk of responses were obtained from the soldiers at Fort Lewis some 11 days after their last day on the fire line. Because the majority of questionnaire items called for judgments or estimations, inadvertent bias may have influenced the latter group's responses due to faded memories or a relaxed after-the-fact attitude. This possibility was examined by reanalyzing the questions as a function of location of administration (Fort Lewis vs Yellowstone area; for sample size considerations, the records of those obtained at Bozeman & Yellowstone were combined into the latter category).

Data by various categories are shown in Table 16. Those in the Yellowstone area showed a proclivity for more responses to the fire duties and equipment items. Weight loss estimations differed as a function of location, as did responses to two of the judgment items.

TABLE 14

Examples of Write in Comments by Enlisted Soldiers to Question Concerning Organization of Activities by Supervisor

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Chain of Command Problems

"No clear cut chain of command. Civilians and military need to get on the same sheet of music."

"Yes by our immediate civilian fire fighter, but the Army at higher levels was trying to run the show. Lots of confusion."

"The firemen and forest service people were excellent on the job. It was our military chain of command that caused all the problems."

"Our crew chief was terrific, but our division leader was poor."

"Team level yes/division level no."

"Yes at the company level but not higher."

"At the company and strike team level it was very organized. When we got a clear mission organization was high. Battalion and higher levels often would not give us clear and organized tasks."

"Not all the time because of higher echelon confusion."

"By the captain, not the battalion staff."

"Only at crew level. If it was war people would have died from lack of communication in higher ranks."

Lack of Feedback, Poor Communications, or Inconsistent Plans

"We had no (or little) knowledge of what was going on until that day the work was to be done."

"They would tell us one thing, then change it when we got there. Once we got working, things became organized."

"They were constantly contradicting each other."

"Continually changing itineraries"

"A lot of the time nobody knew what we were supposed to do. Somewhere between the civilians and the military communications broke down."

"Sometimes they didn't know what we were to be doing."

TABLE 14, cont.

Examples of Write in Comments by Enlisted Soldiers to the Question Concerning Organization of Activities by Supervisors

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Lack of Feedback, Poor Communications, or Inconsistent Plans, cont.

"Everything changed every 5 minutes."

"They didn't know what they were doing. They ... tried to make us think they did [and as a result] put us through unjust hardships."

"Lack of communications play a big part in the unorganized feeling."

Inactivity or Poor Useage of Time

"There were many days we would go up in the mountains and sit for hours in spots because there was nothing for us to do there. If they are going to involve troops again, they should have a clear cut objective and be allowed to accomplish it ..."

"There was a lot of wasted and unproductive time."

[The second group of soldiers who were sent from Fort Lewis] "found that there was nothing to do and proceeded to work the long hours getting a minimum amount of sleep because of doing 'busy work'."

"The civilian strike team leader was not well organized. Much time was wasted in getting to the fire and loitering around after the job was done."

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TABLE 15

## The Influence of Enlisted Rank on Responses

Questionnaire Item	Measure	Rank		Statistical Test Results
		E1-E4	E5-E8	
<b>Completeness in Re- sponding</b>				
No. of Fire Line Activities Cited	Average	2.8	2.7	$t < 1$ , $df = 828$
No. of Pieces of Equipment Cited	Average	3.1	2.9	$t = 1.3$ , $df = 828$ , $p < .2$
<b>Estimations</b>				
Longest Continuous Mission	Days (median)	4	4	Chi square = 1.2, $df = 1$ , $p < .5$
Perceived Stamina	Hours (median)	24	36	Chi square = 26.0, $df = 1$ , $p < .001$
Weight Change	Pounds Lost (average)	5	6	$t < 1$ , $df = 768$
When did Your Ability to do Physical Work Decrease?	Days (median)	5	7	Chi square = 2.4, $df = 1$ , $p < .25$
<b>Judgments</b>				
Military Experience in Long Workdays?	% Yes	85	95	Chi square = 16.3, $df = 1$ , $p < .001$
Fatigue Status at Start of Duties	% Somewhat or Very Tired.	79	77	Chi square < 1, $df = 2$
Fire Fighting Phys- ically Harder than FTX tasks?	% Yes	88	86	Chi square < 1, $df = 1$

TABLE 15, cont.

## The Influence of Enlisted Rank on Responses

Questionnaire Item	Measure	Rank		Statistical Test Results
		E1-E4	E5-E8	
Judgments, cont.				
Ability to do Work Decrease over Time?	% Yes	64	49	Chi square = 15.6, df = 1, p < .001
No. of Reasons for Decrease in Ability to do Work	Average	2.1	1.7	t = 3.5, df = 455, p < .001
Personal Safety ever Threatened by Fire?	% Yes	57	50	Chi square = 3.3, df = 1, p < .10
Activities well Organized by Supervisor?	% No	56	43	Chi square = 10.0, df = 1, p < .005

Abbreviations: FTX = field training exercise.

TABLE 16

## The Influence of Location of Questionnaire Administration on Responses

Questionnaire Item	Measure	Location		Statistical Test Results
		Yellowstone Area	Fort Lewis	
<b>Completeness in Responding</b>				
No. of Fire Line Activities Cited	Average	3.2	2.5	$\bar{t} = 6.4, df = 828, p < .001$
No. of Pieces of Equipment Cited	Average	3.4	2.9	$\bar{t} = 5.3, df = 828, p < .001$
<b>Estimations</b>				
Perceived Stamina	Hours (median)	24	24	Chi square < 1, df=1
Weight Change	Pounds lost (average)	7	5	$\bar{t} = 4.9, df = 763, p < .001$
When did Your Ability to do Physical Work Decrease?	Days (median)	5	6	Chi square = 2.0, df = 1, p < .25
<b>Judgments</b>				
Fatigue Status at Start of Duties	% Somewhat or Very Tired	81	77	Chi square = 3.3, df = 2, p < .25
Fire Fighting Physically Harder than FTX Tasks?	% Yes	94	84	Chi square = 15.3, df = 1, p < .001

TABLE 16, cont.

## The Influence of Location of Questionnaire Administration on Responses

Questionnaire Item	Measure	Location		Statistical Test Results
		Yellowstone Area	Fort Lewis	
Judgments, cont.				
Ability to do Work Decrease over Time?	% Yes	55	63	Chi square = 4.6, df = 1, p < .05
No. of Reasons for Decrease in Ability to do Work	Average	2.0	2.1	$t < 1$ , df = 455
Personal Safety ever Threatened by Fire?	% Yes	52	57	Chi square = 1.8, df = 1, p < .25
Activities well Organized by Supervisor?	% No	57	50	Chi square = 3.0, df = 1, p < .10

Abbreviations: FTX = field training exercise.

## DISCUSSION

The Yellowstone mission represented a noncombat deployment, but in the sense of its lack of notice was somewhat representative of mobilization for combat. Daily sources of stress included long workdays, heavy smoke and thick ash, steep terrain, high altitude, occasional periods of intense work (to include load carrying, hiking, and use of tools), wide range in ambient temperature, and danger from flames, falling trees, and fire fighting equipment. Performance and stamina for physical work in this unique environment for soldiers were assessed indirectly via responses to a questionnaire.

The fatiguing nature of extended fire line duty and its impact on performance is of obvious concern to the Forest Service, which has identified the following sources of fatigue: "In addition to lack of adequate rest, such things as carbon monoxide (CO), smoke inhalation, heat stress due to either climatic conditions, or radiated heat, fluid replacement, mental attitude and physical condition can contribute to fatigue" (US Forest Service, 1984, p. 2). The following paragraphs discuss findings from the questionnaire which illustrate the influence of various aspects of the mission on soldier performance.

Although formal sleep periods were a part of a typical day's schedule, the chronic nature of the duties--repeated long workdays under stressful conditions--may have led to physical fatigue for many. Eighty-seven per cent of the respondents rated their duties as physically more taxing than those in FTXs. One explanation for this rating may be that physical training and conditioning for combat are not necessarily equivalent preparations for fire fighting; that is, different muscle groups are required for fire line work and its sustained nature. Alternatively, FTXs may simply not be as demanding as fire line duty. Ability to do work was perceived as decreasing over time on the job by 60 per cent of the respondents; the estimated median time of perceived decline in capability was 5 days (average of 7). It should be noted that typical US Forest Service policy is one day off in seven, if circumstances warrant, or at least two days off in fourteen. In spite of the stated hard physical nature of the work, the physical conditioning of the soldiers allowed full unit strength to be maintained throughout each day of the mission (Dept. of Defense, 1988, p. 1-31); given the respondents' comments, however, presence on the fire line is not necessarily equated with 100 per cent performance capability at all times.

The earlier deployed task forces had more actual fire fighting duties and less stand-down time because of the state of the fires and relatively lower number of available fire fighting personnel; by contrast the last deployed GTF listed the lowest percentage of "cutting fire breaks" and the highest percentage of "fuel reduction" duties. Based on subjective comments by the soldiers, motivation seemed highest when engaging in goal-oriented fire fighting duties per se. Fuel reduction ("park beautification") work and waiting-around time were not viewed favorably. Perceived importance of duties may therefore have impacted negatively on performance, and this concept would be worthy of further study in such missions.

A concern about the effects of wrongful expectations on soldier motivation, morale, and performance was expressed in the Lessons Learned

section of the DOD JTF AAR: "Firefighting is 'challenging' during the first week on the line; the second week the work is 'interesting' and the soldiers learn good habits and build stamina for working at high elevation. The third week is very productive but boredom begins to show and the enthusiasm begins to tail off unless the troops are employed against an active fire. The fourth week was a high safety risk....Soldiers should be actively engaged in fighting fires when deployed. Commitment to hot spots with minimal time employed in restoration activity will reduce boredom and take advantage of military firefighting stamina. A maximum deployment time of 21 days equivalent to civilian counterparts should be maintained for DoD personnel" (Dept. of Defense, 1988, p. 2-2).

Many of the response patterns to the questions showed differences among the Ground Task Forces (8 of the 11 tests reported in the table footnotes). Because the questionnaire was a "one shot" endeavor after fire fighting activities had ceased, it is difficult to ascertain what incidents or experiences were foremost in the minds of the respondents when completing the forms. Multiple administrations during the mission would have, of course, provided more information. If the one-time, after-the-fact approach is necessary, access to the troops as soon as possible would be desirable. In terms of completeness of responding, those in the Yellowstone area gave more fill-in responses to fire line activity and equipment questions; thus, better compliance may be obtained with timely, on-the-spot administration.

Based on the above results, the usefulness of this type of field investigation is as follows. (1) Many rated the experience as dangerous, suggesting that support operations on this kind of natural disaster can partially mimic some stresses of the battlefield. (2) Although the majority of respondents stated previous experience in long military workdays, many found the physical nature of fire fighting to be more difficult than their duties in field training exercises. It may be beneficial to perform a fatigue-taxonomic analysis of fire line tasks for comparison to duties in FTX scenarios. (3) Fire fighting is a test of the soldier conditioning program. (4) Deployment for fire fighting offers an opportunity to study the fatiguing aspects of getting to the "battlefield" (see e.g., Wright, et al., 1980). (5) A study of a fire fighting mission can provide information on what components of military scenarios and leadership lower morale and motivation, and hence reduce performance. It is apparent from the present data that the soldiers needed a sense of purpose (i.e., they are not attuned to busy work or boredom on a mission), and organization. (6) Ascertaining the reasons behind differences in response patterns as a function of rank category may provide worthwhile information on command structure. For example, the perceived stamina estimations were highest for officers and the high-rank enlisted group. Because of a belief of high stamina or an actual or perceived need to be awake for long periods, those in command and control positions often go without adequate rest during missions such as FTXs or the NTC. A growing military literature (e.g., Dept. of Army, 1983; Dewulf, 1987; Frank, 1982; Geier, 1979; Newman, 1987; & Thompson, 1983) attests to the performance declines which ensue. Given the above points, fire fighting does appear to be a viable data source for information on extended operations which could pertain to combat.

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## APPENDIX A

### JOINT TASK FORCE YELLOWSTONE CHAIN OF COMMAND

Each Commander of a Battalion Task Force (BTF) worked closely with the Incident Commander (IC) and his staff. The IC was responsible for organizing and planning the fire fighting operations against the entire fire incident. The IC, in coordination with the BTF Commander, provided military assignments, issued fire fighting priorities, and ensured resources were provided in order to complete the daily missions. Fire shift plans were written each night and disseminated the following morning at the shift plan meeting to Battery/Company Commanders.

At the Company/Battery level a civilian Strike Team Leader was assigned to provide guidance to the Company/Battery Commander on the positioning of the Fire Crews. Each Strike Team was responsible for two twenty man Fire Crews.

A civilian Crew Boss was assigned to each Fire Crew of twenty military personnel. The Crew Boss was responsible for advising the NCO in charge of the Fire Crew on all fire fighting operations. The experience of the Crew Boss in fire fighting was of particular assistance to the Fire Crew and he also provided a key to the safety of the fire fighting effort. Although at all levels the civilian liaison was assimilated into the military infrastructure, at no level was the camaraderie and sense of belonging greater than at the Fire Crew levels. Crew Bosses were literally "adopted" by the military Fire Crews.

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Source. The above paragraphs are from the DOD Joint Task Force Yellowstone After Action Review (Dept. of Defense, 1988, p. 1-3).

Note. The Incident Commander is a US Forest Service employee.

## APPENDIX B

### TYPICAL FIREFIGHTING DAY

The typical firefighting day for the DoD military personnel of JTF Yellowstone began at their base camp with wake up at 0530 hrs. Base camps were of a varied nature; the existing facilities, travel lodges, motels, camp sites etc. were utilized when available. When hard facilities were not available, troops were quartered in GP medium tents, Forest Service A frame tents, or pup tents. Immediately after wake up, personnel used the time available to conduct personal hygiene. Hot showers, shaving basins with mirrors and porta-potties were available at the base camp. From 0530-0830 breakfast was served by USFS contracted caterers and sack lunches picked up. These sack lunches were carried by the firefighters to the fireline. Personnel boarded busses at the base camp at 0800 and were transported as close as possible to the fire. Busses remained at a drop point parking area while the DoD military firefighter walked up to 9 miles to the fire line.

Firefighters generally worked in twenty man fire teams under a non-commissioned officer and a USFS crew boss....During the day, firefighters were commonly given 10-15 minutes break per hour to rest and fill up their canteens. The DoD military firefighter carried two canteen quarts of water; refills were made from 5 gallon cube packs that were transported to drop points by support vehicles and then carried to the fire lines by members of the fire team.

Firefighters typically remained on the fire line until 1900 hours, walked out to a pick up point and were bussed back to their base camp. Once back at the base camps, firefighters could utilize the outstanding services provided by the USFS. Fruit, candy, soda, ice cream and other snacks were available 24 hours a day free of charge. Free phone calls were available on USFS provided commercial phones. At most camps, television was available for the firefighters. A contract catered evening meal was generally served around 2000 hours. Most units ensured personnel were bedded down by 2200 hours each night.

All fire teams were given Rest and Recuperation days as fire conditions permitted. These days were spent sightseeing or relaxing, with busses providing transportation to R and R sites. Many of the first contingent of DoD military firefighters were given only 3 days of R and R during 29 days of deployment due to the extremely bad fire conditions at the time of their deployment.

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Source. The above paragraphs are from the DOD Joint Task Force Yellowstone After Action Review (Dept. of Defense, 1988, p. 1-9).

APPENDIX C

COMMENTS BY SOLDIERS TO THE PRESS CONCERNING  
CONDITIONING AND FOREST FIRE FIGHTING

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Comment	Source
"Back home, we run five or six miles every day and we're in good shape. Plus, we're used to being miserable and still performing."	McMillion, 1988, p. 27
"We're infantrymen. We're used to walking long distances, sleeping on strange schedules and under less-than-optimum conditions."	Miles, 1988, p. 17
"Hard work? ... Not for us. We're infantry, we dig fox holes and stuff."	Brock, 1988, p. 9
"We walked three days--12 miles each day--just to get to the fire. <u>Then</u> we worked all day. That's motivation."	Bogino, 1988, p. 17

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