

STUDY REPORT
CAA-SR-89-10

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FIRE FIGHTING TASK FORCE (FIRE)

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PREPARED BY
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STUDY REPORT
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FIRE FIGHTING TASK FORCE

(FIRE)

April 1989

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**FIRE FIGHTING TASK FORCE
(FIRE)**

**STUDY
SUMMARY
CAA-SR-89-10**

THE REASON FOR PERFORMING THE STUDY was to determine whether forest fire fighting causes combat-like stress, and if so, determine the factors that cause the stress. In other words, find out whether studying forest fires adds to our knowledge of combat effects on the soldier and soldier performance in combat. Assuming that forest fire fighting is somewhat similar to combat, results will be useful in developing algorithms and data for use in US Army Concepts Analysis Agency (CAA) combat models.

THE STUDY SPONSOR was the Director, US Army Concepts Analysis Agency.

THE STUDY OBJECTIVES were to:

- (1) Collect and analyze data on the fatigue and stress of forest fire fighting.
- (2) Determine the major factors that cause fatigue or stress when fighting forest fires.
- (3) Decide whether the effects of forest fire fighting are similar to the effects of actual combat.
- (4) Develop estimates of soldiers' performance during combat and assure that they are in a form that can be used as data in combat models.
- (5) Build an information base for building a more complete field study which measures the factors that cause forest fire fighting stress and the differences in soldier performance which are caused by those stresses.

THE SCOPE OF THE STUDY is limited to analysis of data collected from Army soldiers who fought forest fires in and around Yellowstone National Park. Civilian fire fighters are not included because we have no baseline measurements and would not be able to obtain them. Marines are not included; they arrived after most of the fires had been contained.

THE MAIN ASSUMPTION is that soldier reaction to stress caused by forest fire fighting, as measured by their performance on assigned duties, will be similar to their reactions from the same stressor caused by actual combat.

THE BASIC APPROACH was to quickly form a multidisciplinary, multiagency team of human performance and stress measurements experts, collect as much data from the soldiers who fought the fires as possible in the limited time available using both questionnaires and interviews, then obtain the unit's After Action Report (which provided additional detail). The research agencies individually analyzed the data they collected; CAA integrated the results.

THE PRINCIPAL FINDING OF THE STUDY is forest fire fighting causes higher stress levels than the Army has measured in laboratory settings and is therefore combat-like. However, we believe that the stress is less than combat stress. The number of days that the soldiers actually faced blazing fires seemed to be 13 or fewer during approximately 4 weeks at Yellowstone. We identified a variety of stressors at Yellowstone. They range from traditional combat stressors (such as fatigue, terrain, and fear), to Yellowstone unique stressors (working with civilians), to stressors that were stressors at Yellowstone, will probably be stressors in combat, and are not usually studied as stressors because Army field exercises are expected to condition the soldiers to them--austere living conditions and hostile environment. Since they seemed to be stressors at Yellowstone, we believe the latter should be expected stressors in combat.

THE KEY OBSERVATION is that officer responses were very different from enlisted responses. The enlisted soldiers rated the Yellowstone experience as more stressful and as more life-threatening. They felt their coping efficacy was lower. They were more depressed, more hostile, more anxious, and had fewer good feelings about themselves. Their duties were more physically difficult and probably more life-threatening. It is important to know whether there is something unique about fighting forest fires, or whether these differences should be expected in most operations, particularly combat. Since knowing the psychological changes that result from combat or combat-like operations may help in developing techniques that will avoid the high rates of neuropsychiatric breakdowns expected during intense combat, we believe these results have important implications.

THE STUDY EFFORT was directed by Ms. Sally J. Van Nostrand, Force Systems Directorate. Other Army agencies participated in the study--US Army Research Institute for the Behavioral and Social Sciences, US Laboratory Command Human Engineering Laboratory, and Walter Reed Institute for Research.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FS, 8120 Woodmont Avenue, Bethesda, MD 20814-2797.

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STUDY SUMMARY (tear-out copies)

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FIRE FIGHTING TASK FORCE (FIRE)

CHAPTER 1

EXECUTIVE SUMMARY

1-1. BACKGROUND

a. Military analysis agencies are developing an interest in changing the present firepower models into more representative combat models by adding soldier dimensions. The US Army Concepts Analysis Agency (CAA) is committed to adding the soldier variables and algorithms that are necessary to fully represent combat. The FIRE Study is part of a continuing effort to better quantify soldier performance factors in combat so that they can be included in combat models.

b. In August, 1988 the Army was called in to fight forest fires in Yellowstone National Park and the contiguous states. We at CAA discussed the relationship of forest fire fighting to combat and whether study of forest fire fighting could add to our knowledge of soldier performance in combat. In some ways, forest fire fighting seems to be similar to combat--forest fire fighting contains elements of both continuous operations and an actual enemy. It may be an inanimate enemy, but it is real, it is dangerous, and it frequently does the unexpected. However, since CAA does not normally perform field studies, we did not decide to do it ourselves. By 21 September, when ODCSOPS informed us that snow was putting out the fires and the soldiers were redeploying, the Director, CAA, with the concurrence of ODCSOPS, approved the hasty organization of a task force to study the Army forest fire fighters at Yellowstone National Park.

c. Since this was a unique opportunity for research that is seldom otherwise available, other Army agencies were invited to participate in the task force. They are: (1) US Army Research Institute (ARI) Systems Research Laboratory (SRL); (2) US Army Materiel Command (AMC), Laboratory Command (LABCOM), Human Engineering Laboratory (HEL) Behavioral Research Directorate; and (3) Walter Reed Army Institute of Research (WRAIR) Department of Behavioral Biology.

1-2. STUDY OBJECTIVES. These objectives were developed for the Fire Fighting Task Force (FIRE) Study:

a. Collect and analyze data on the fatigue and stress of forest fire fighting.

b. Determine the major factors that cause fatigue or stress when fighting forest fires.

c. Decide whether the effects of forest fire fighting are similar to effects of actual combat.

d. Develop estimates of soldiers' performance during combat and assure that they are in a form suitable for use as data in combat models.

e. A secondary objective is to build an information base for designing a more complete field study.

1-3. **SCOPE.** The FIRE Study is limited to analysis of data collected from Army soldiers who fought the forest fires in and around Yellowstone Park. Civilian forest fire fighters are not included because they have no physical or age standards, may not have the same quality of leadership, and probably do not have the high levels of unit cohesion and morale as are found in Army units. They have not been trained to function as a well-disciplined unit. Army fire fighters in garrison do not have continuous danger and do not have a requirement to work to the exhaustion point.

1-4. STUDY PLAN DEVELOPMENT

a. On the first day of this study, 21 September 1988, a team of human performance and stress measurement research experts was created by a series of telephone discussions. CAA asked for human research expertise and data collection instruments in exchange for the unique opportunity to collect data in a real operational environment.

b. An ARI researcher who had studied fatigue from sleep loss in continuous operations and fatigue from wearing chemical-protective clothing developed a questionnaire (Appendix D) for this study. In addition to asking questions about sleep loss and fatigue, he designed it to provide background information on the fire fighting experience that might be necessary to more fully understand all of the data collected and which might not otherwise be available. He included questions suggested by WRAIR about weight loss versus food and water availability. The ARI analysis of this questionnaire data is provided in Appendix E.

c. For the FIRE Study, the HEL researchers selected a group of questionnaire items which they had used in several previous studies on stress in Army soldiers and added background questions (Appendix F). Most of the items for which the soldiers used a 0 to 100 rating scale (rating of events, page F-7; successful about getting job done, page F-8; and coping efficacy, page F-9) were items used in other studies with only the referent situation changed in each. Pages F-4 and F-5 ask the soldiers to select from a set of adjectives to describe how they feel right now (page F-4) and during the fire fighting (page F-5). The set of adjectives is called the Multiple Affect Adjective Check List-Revised (MAACL-R). The MAACL-R is a standard test that has been validated on other populations outside the military, as well as within the Army ("Revised" does not mean revised by HEL). Although the MAACL-R can be used for providing clinical diagnoses of psychological disorders, it has been validated for measuring situational mood changes, i.e., cognitive and emotional reactions to specific situations based on respondents' (in this case, soldiers') perceptions of what is happening to them. The HEL analysis of data from this questionnaire is provided in Appendix G.

d. In the afternoon of 23 September, the team arrived in West Yellowstone, Montana, the location of the headquarters of the Department of Defense Joint Task Force (JTF), Yellowstone.

1-5. DATA COLLECTION PHASE. As should be expected in an operational environment, we did not have laboratory conditions for questionnaire administration and had little choice as to when, where, and to whom we would administer the questionnaires.

1-6. A FIRE FIGHTING DAY AT YELLOWSTONE

a. Sleep. The Forest Service used previous ARI research to determine that all fire fighters should have 1 hour of rest or sleep for every 2 hours of work and time getting to the work area. Because nights usually have higher humidity, the Forest Service allows the fire to burn at night. Scheduled sleep was usually 2200 to 0500.

b. Getting to Work. Getting to the work site was sometimes very difficult and time-consuming. Although the soldiers usually hiked lesser distances, were bussed, or were flown to the work site, there were times when they hiked 10 or 12 miles in each direction. ("Hiked" is the word used by all soldiers of all ranks to describe the activity normally called "march" by the Army.)

c. Environment

- **Temperature.** It was summer when the soldiers arrived. In September, the first snows fell, and some soldiers were not prepared. The Forest Service provided sleeping bags, and the soldiers could use more than one if they were cold.
- **Terrain.** It was sometimes so steep that the fire fighters used a fire line to hoist themselves up or to hold themselves in place while working. Most got blisters on the back of the ankle from the boot counters; they blamed that on the terrain. The altitude ranged from about 6,600 feet in the town of West Yellowstone, Montana, to more than 10,000 feet in many areas of the park.
- **Smoke.** The doctors estimated that the soldiers probably inhaled smoke equivalent to smoking four packages of cigarettes a day, and that it may take as long as 6 months for their lungs to return entirely to normal.
- **Wind.** At Yellowstone, the wind seemed an ally of the fire. It frequently caused the fires to jump fire breaks.

d. Tasks and Equipment. Nearly all of the soldiers were assigned to physical labor that easily fits the Army category of "very heavy." Most of the fire fighting equipment items are very tiring to use. The Pulaski (an axe) has a handle about 30 inches long. The McLeod (a heavy duty rake for coals and digging underbrush) has a 48-inch handle. Although the Combi tool has a longer handle, there are not yet very many in the inventory, and very few used it. It is a newer tool than the Pulaski or McLeod and is a redesign of an Army trenching tool from the 1950s. The back pump is a 5-gallon water bladder, worn on the back. As well as their tools, the soldiers carried drinking water.

e. **Organization.** The Boise Interagency Fire Center (BIFC) had overall control of the forest fire fight. Each military fire fighting crew was led by an experienced civilian fire fighter who provided the required expertise in fire fighting.

g. **Safety Considerations.** Both the Forest Service and the military consider human life more important than trees and grass. When there was a choice between fighting the fire and safety of personnel, personnel safety was the option chosen. There were very few serious injuries. In this respect, the fight at Yellowstone was not representative of combat.

1-7. **ESSENTIAL ELEMENT OF ANALYSIS 1.** What are the major factors that cause stress while fighting forest fires? We identified a wide variety of stressors at Yellowstone. They are described below.

a. Most traditional combat stresses exist, but usually in a different form.

- Fatigue from sleep loss from continuous operations is expected to be a major combat stress. At Yellowstone the major stress was fatigue, but from physical exertion.
- Fear of injury or death is present in combat and at Yellowstone. At Yellowstone, the major components are fire and falling trees.
- The soldiers were not physically prepared for the terrain difficulties. Yellowstone National Park and the surrounding area is mountainous terrain, as is Korea, many areas of Europe and Third World areas. Hiking to work sites and performing the required work on steep slopes intensifies the physically fatiguing aspects of fire fighting. The distances between the work sites and the base camp sometimes necessitated sleeping in "spike" camps with food and water airdropped.
- Temperature extremes were present at Yellowstone.
- At first, precipitation was not a stressor, but later, precipitation in the form of snow was a stressor.
- Other traditional combat stressors (noise, crowding, darkness and chemical environment) were not problems at Yellowstone.

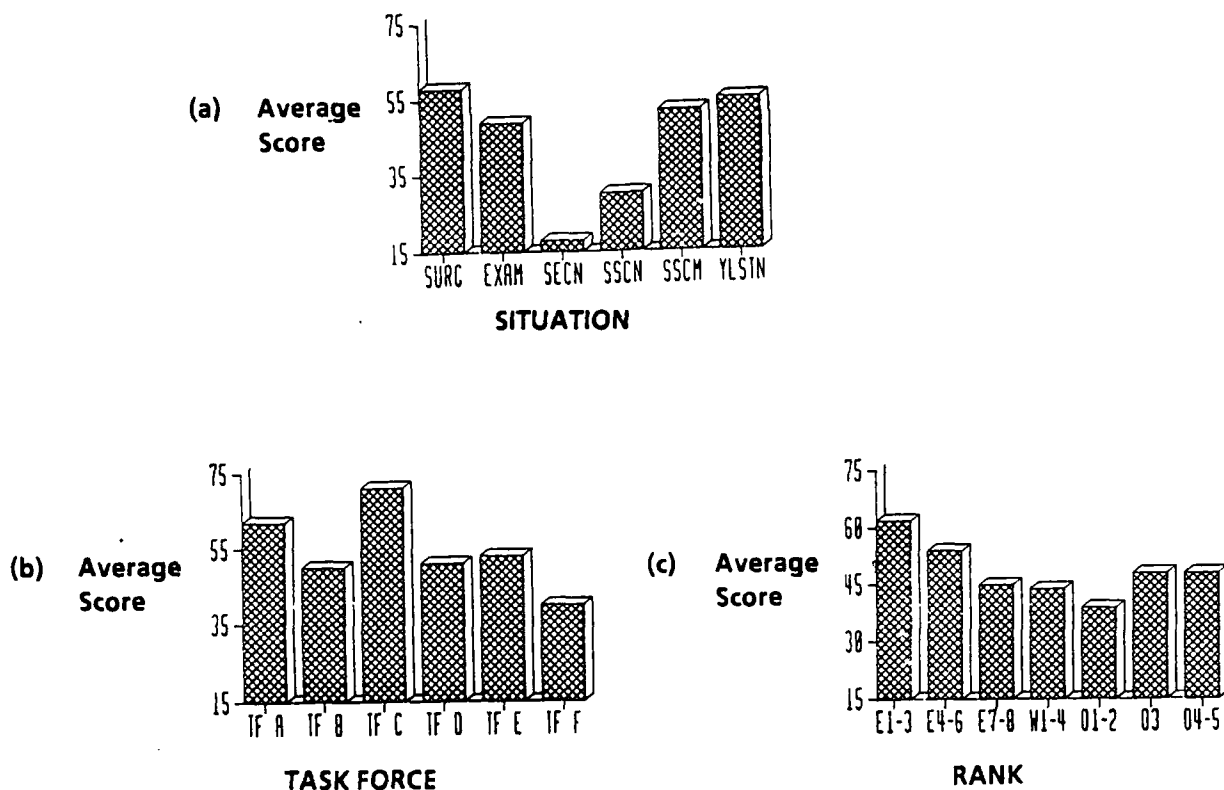
b. Austere conditions and a generally hostile environment were found at Yellowstone and should be included with traditional stressors. Yellowstone stressors which should be sometimes expected in combat are uncertainty about today and the future, boredom or a lack of feeling useful, high altitude (6,600 to 10,000 feet), and breathing smoke and ash.

c. Unique-to-Yellowstone stressors are working with civilian fire fighters and inexperience with equipment. These might provide useful insights to soldiers ability to cope with working with Allies and with Allied weapon systems.

1-8. EEA 2. Does forest fire fighting cause combat-like stress? Forest fire fighting does cause combat-like stress. However, the stress levels we found are less than we would expect in combat.

a. Forest fire fighting causes high stress levels. The data shown in Figure 1-1 are from ratings of how stressful soldiers and civilians consider a specific event (0 represents no stress; 100 represents the maximum possible). The data were collected by HEL. In the chart labeled "a," all Yellowstone soldiers are averaged in the right bar for comparison with respondents in several other situations. The left bar (SURG) represents spouses of patients undergoing abdominal surgery. The next (EXAM) represents medical students taking a major written examination, and SECN the surgical/examination control group. SS stands for Salvo Stress Study. In it, HEL studied airborne soldiers. SSCN is the average rating for the control group firing at targets with little stress. The average rating for airborne soldiers firing at targets in a highly competitive marksmanship setting is SSCM. Yellowstone soldiers in the aggregate do not score significantly differently than respondents in other situations except for the two control groups. However, the data by task force (chart b) shows that there is a significant difference between the task forces, as is there between the lower ranks of enlisted soldiers and the higher ranking enlisted or the officers (chart c). Statistical significance is shown visually in the graphs in Appendix G by graphing the standard errors as vertical lines above the bars (called here, a "hat"). Picture each vertical line extending down into the bar so that an equal amount, plus and minus from the average (the top of the bar), is shown. When the top of one hat does not overlap with the upside down hat of another bar, the differences are significant. By comparing bars which represent small numbers of respondents with bars which represent large numbers of respondents, you can see that large numbers in the sample tend to reduce the size of the standard error, and therefore tend to increase the significance of the differences in the bar heights.

b. Stress levels are correlated with number of days fighting flames and negatively correlated with rank. Task force F is clearly different from the other task forces. The difference is partially explained by the breakout by rank, Table 1-1. Half of this "task force" is officer or warrant officer. The rest of the difference between task forces seems to be explained by the number of days that some portion of the task force spent battling actual flames (fires on hot lines, protecting structures, and setting and controlling backburns). When the number of fire fighting days is charted in bar graph form, as in Figure 1-2, you find a pattern very like Figure 1-1. The rest of the bar graphs in this report and the appendices show this same pattern. Task force C and then task force A are higher on the negative measures and lower on the positive measures than the other task forces. Task force F is always the opposite of task force C. Similarly, the lower ranks of the enlisted soldiers are always different from the officers.



Source: Human Engineering Laboratory.

Figure 1-1. Ratings of Event Stress (possible range is 0 to 100)

Table 1-1. Task Force Profiles by Rank

Task force	Rank							Total
	E1-E3	E4-E6	E7-E8	W1-W4	O1-O2	O3	O4-O5	
A	66	90	3	0	8	4	1	172
B	28	125	15	4	13	3	0	188
C	53	88	5	0	4	2	0	152
D	27	52	1	0	8	2	0	90
E	65	135	15	1	26	9	2	253
F	1	29	1	20	3	7	1	62
Total	240	519	40	25	62	27	4	917

Source: HEL.

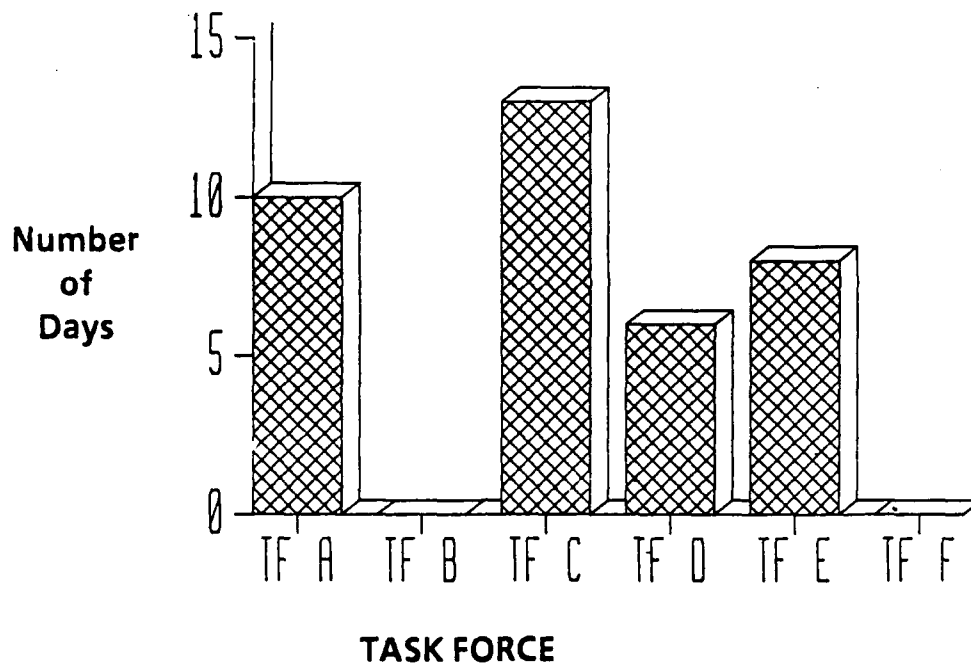


Figure 1-2. Fire Fighting Days by Task Force

c. EEA 2 Summary. Yes, the stress of forest fire fighting is combat-like, but the "yes" must be a qualified yes. The danger in forest fire fighting is usually less than combat danger. Sleep loss suffered in forest fire fighting is probably less than is expected during periods of intense combat. The physical stress of forest fire fighting may be greater than combat and is greater than that for which the soldiers train. Even though both danger and sleep loss stress are minimized, the stress levels of forest fire fighting are higher than in any of the other situations measured to date.

1-8. EEA 3. How does sleep loss affect soldier performance? The time that was scheduled for sleeping should have been adequate for most soldiers. Although many complained in the questionnaires of inadequate sleep periods, we do not know how severe sleep loss may have been. The fires went out so quickly that we were not able to collect objective data on sleep loss. For now, Army Field Manual, FM 22-9, Continuous Operations, is still the best, most easily accessible data source for sleep loss effects.

1-9. EEA 4. How do other stresses affect soldier performance? Over time, the soldiers' ability to work decreases. This may be caused by a combination of both physical and mental stress.

a. The soldiers started tired. Table 1-2 shows the enlisted soldiers' responses by task force for several questions for task forces A through E. Since the duties of officers and aviators were much different from the majority of the soldiers' duties, task force F is not shown and these data are enlisted soldiers only. The data were collected with the ARI questionnaire. Apparently, the deployment process itself is tiring. Tired soldiers are not 100 percent productive or efficient soldiers.

Table 1-2. Selected Questions by Task Force (enlisted only)

Question	Response	Percent by task force					All enlisted records
		A	B	C	D	E	
How tired at start?	Somewhat or very tired	75	82	77	78	79	78
Fire fighting physically harder than MOS tasks?	Yes	95	97	86	80	76	86
Ability to work decreased over time?	Yes	65	53	75	44	58	60
So tired someone became dangerous?	Yes	36	28	34	19	30	29
Question	Response	Number of days					All enlisted records
		A	B	C	D	E	
Got tired to point physical work was affected?	Days	7.7	6.1	8.1	7.1	6.5	7.2

Source: Army Research Institute.

b. The work was tiring. The percentage of soldiers (Table 1-2) that felt that forest fire fighting was physically harder than their military occupational specialty (MOS) tasks is striking. Most felt their ability to work decreased over time. Nearly one-third felt that they or someone around them became so tired that they became dangerous to themselves or to those around them. The time at which they tired seems to be relatively consistent. Interestingly, TF C gave the longest time span they could work before their ability to do physical work was affected.

c. The soldiers seem to have lost weight. The soldiers' estimate of their weight change on the ARI questionnaire is shown in Table 1-3. Since two of the task forces were at Fort Lewis, we assume that many may have had an opportunity to weigh. Some of the reason for feeling they lost capacity for physical work may have been from a feeling of weakness caused by losing weight or becoming dehydrated.

Table 1-3. Estimated Weight Change

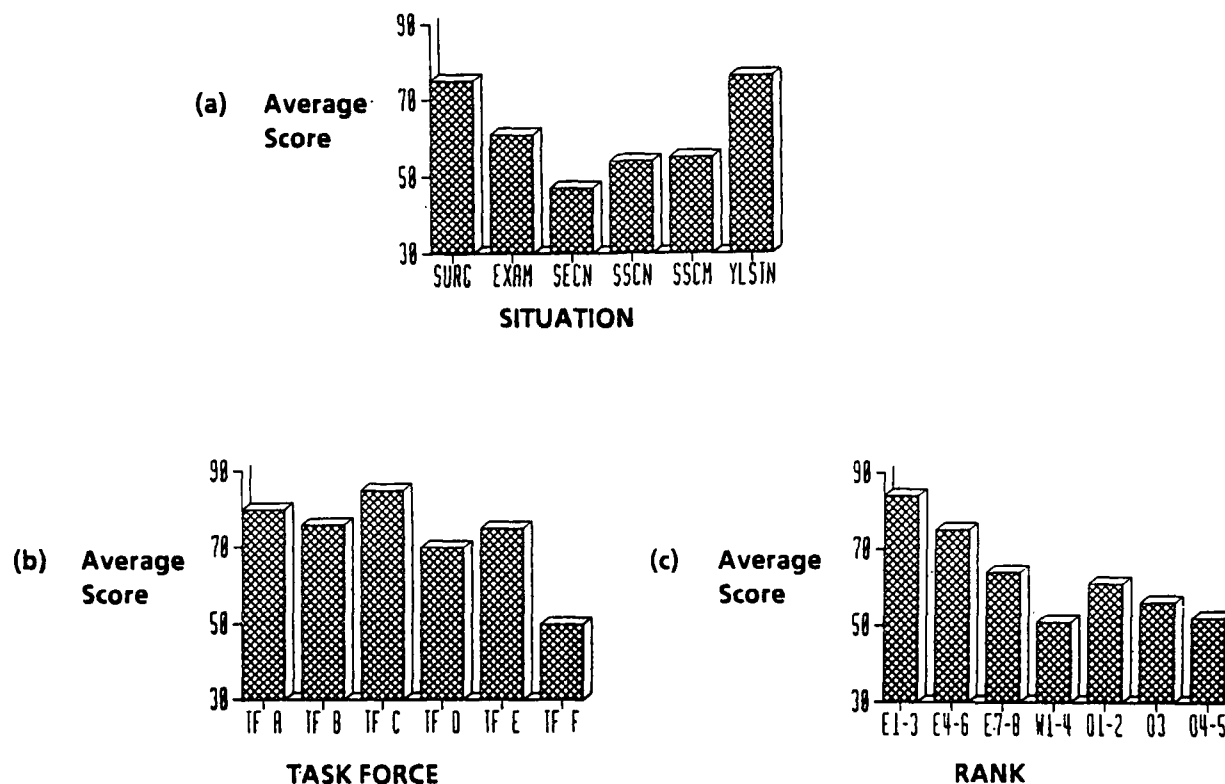
Question	Task force					All enlisted records
	A	B	C	D	E	
Indicated lost ^a	57	83	67	61	54	66
Indicated no change ^a	42	16	33	38	41	3
Indicated gained ^a	1	1	0	1	5	2
Average estimated weight change ^b	-4.7	-7.5	-6.0	-5.2	-4.3	-5.5

^aPercent.

^bPounds.

Source: ARI.

d. Soldiers are depressed. The next figure, Figure 1-3, shows the depression ratings for Yellowstone compared with other situations (chart a), by task force (chart b), and by rank groups (chart c). On chart a, the differences are significant except between Yellowstone (YLSTN) and moderate surgery (SURG) and between the marksmanship groups (SSCN and SSCM). The possible range for this rating goes from 40 to 338. Therefore, the highest average measurement (E1-E3) is less than one-third of the possible highest score. We do not know what the depression rating might be for a soldier who develops combat fatigue (becomes a neuropsychiatric casualty).



Source: HEL.

Figure 1-3. MAACL-R Depression Ratings
(possible range is from 40 to 338)

e. **Soldiers are uncertain.** A topic that came up over and over again in interviews and in comments on the questionnaires is uncertainty. First, the soldiers were uncertain about when they would go home. Many were told several different times, one after the other--first they were told 10 days, then the time was lengthened to 14 days, next to 21 days, and finally a month. On a daily basis, they were uncertain about what the work for the day would be, where they would do it, how they would get there, and how they would get back to camp. The soldiers were uncertain about their families, mortgages, and car payments. When performing fuel reduction duties rather than fighting fires, they were uncertain about why they were still there.

f. **Soldiers were stressed at Yellowstone.** We are uncertain at this point as to which stressors caused the stress. We believe that they were physically stressed. We also believe that they were psychologically stressed, but we cannot say whether the psychological stress was a result of the physical stress or was in addition to it.

1-11. EEA 5. Is either the sleep loss or stress severe enough to continue to another phase which better measures performance on military tasks? Yes, we believe that stress levels were high and that we should continue to plan for another phase.

a. The average stress and related mood levels, even though our measurements were as much as 10 days or more after the stress occurred were still higher than any average levels in previous HEL studies. Therefore, we feel that other forest fires would be a productive opportunity for data collection.

b. There are other situations that we believe would also provide useful information. We would understand these data better if we had a large set of base case data collected from the same group of soldiers when they are not, and have not recently been, stressed, i.e., in garrison. We believe that we should collect similar data at the National Training Center (NTC) and other training situations. A fully prepared multidiscipline, multiagency study team could accompany the soldiers on other military operations (or immediately behind) in an operation such as that in Grenada. The amount, range, and usefulness of data that could be collected in a combat environment are probably greater than could be collected in any training exercise.

c. In this study we were able to collect only perceptions and soldier feelings (subjective data). In another, prepared phase there are objective measures, e.g., military task performance or amount of sleep obtained, that could be collected to complement the subjective data. In addition, there are many improvements that could be made to the questionnaires which would allow us to make more definitive statements about the subjective data.

1-12. EEA 6. What lessons learned should be applied to another phase? The most important lessons are summarized as follows:

a. Be prepared.

- Have one integrated questionnaire.
- There are rich data sources that should all be mined.
- Have both objective and subjective measures.
- Simple responses are easier for the soldiers and analysts.
- Optically-scanned answer sheets are impossible in the field.

b. Be there during the action.

c. Be flexible.

d. Use a simple volunteer document for the soldiers to sign.

e. Use small groups so you can take time for interviews.

f. Allow time in the schedule for the unexpected.

g. Officers on the team get attention, civilians may not.

h. Approach the study with optimism and don't let the study team members become too tired or stressed. This may be the most important item!

1-13. **KEY OBSERVATION.** The officers studied at Yellowstone seemed to be very different from the enlisted soldiers. Whether this is a difference caused by the difference in the duties performed at Yellowstone, or whether this is a difference that always exists is not yet known. Since officers are significantly different from enlisted soldiers on every measure, this seems an important area to study more carefully. There may be important motivation, officer training, and even medical implications.

1-14. **FUTURE PLANS.** We plan several other phases. The first phase will be the preparation phase--it must be completed before the possibility of forest fires needing the active Army, i.e., by July, 1989. The other phases will be studying the Army in various operations--garrison for base case data development, training such as NTC, forest fires, or if there is no fire in 1989, we will be ready to go with (or after if there is real combat) the soldiers in any actual operation to collect important information on the process, the results of the process on the soldiers, and effects of the soldiers on the process.

CHAPTER 2

BACKGROUND

2-1. INTRODUCTION. Military analysis agencies are developing an interest in changing the present firepower models into more representative combat models by adding soldier dimensions. The US Army Concepts Analysis Agency (CAA) is committed to adding the soldier variables and algorithms that are necessary to fully represent combat. This requires developing the techniques and data that are necessary to include soldier characteristics such as performance under varying conditions. Although there is much laboratory research data on human performance, there is very little human performance data which has been collected in near-combat conditions such as field training exercises (FTX). There is less data from actual or near-combat conditions, and during peacetime there seems to be no way to collect new combat data. The data that do exist need some transformation or additional work to translate the information into data elements and algorithms that are usable in combat models. The FIRE Study is part of a continuing effort to better quantify soldier performance factors in combat so that they can be included in combat models. As well as study objectives, elements of analysis, and results, this study report describes the decision process for deciding to do the study, the lessons learned, the procedures used for developing the task force, for developing the study plan, and for administering the questionnaires. Hopefully, this documentation will be useful to others who want to perform a similar field study.

2-2. GENESIS OF THE FIRE STUDY. Data collection in the field during actual operations was common during the early days of operational analysis. Since then the operations research area has grown and each US Army operations research agency specializes in a different area. Some of the other agencies may do field research. However, CAA seldom needs data that are not already collected elsewhere, and field studies for original data collection are not usually considered part of the CAA mission.

a. Nearly 3 years ago, when the forest fires in the western states became more than the resources of the forest service could handle, Army reserve units were activated to fight forest fires. During the final briefing of the first study in this series of studies of soldiers in the combat environment (Van Nostrand, 1986) in September, 1986, we at CAA discussed the relationship of forest fire fighting to combat and whether study of forest fire fighting could add to our knowledge of soldier performance in combat. In some ways, forest fire fighting seems to be similar to combat--forest fire fighting contains elements of both continuous operations and an actual enemy. It may be an inanimate enemy, but it is real, it is dangerous, and it frequently does the unexpected. Therefore, performance data collected from soldiers while they are fighting fires could fill an important gap in present data. We felt that some Army agency should study the military fire fighters at least enough to determine whether further study would enable us to better understand combat. However, since CAA does not normally perform field studies, we did not decide to do it ourselves, and the subject was dropped.

b. In August, 1988, prior to the final CAA briefing of the second project in this series (Van Nostrand, 1988), the Army was again called in to fight forest fires in the western states. This time, however, it was the Active Army that was called. The Director, CAA, suggested to other, perhaps more appropriate agencies and to the Director of Operations for the Office of the Deputy Chief of Staff for Operations (ODCSOPS) that this was an opportunity for research that should not be missed. ODCSOPS agreed, but by the time of the briefing, there did not yet seem to be anyone studying Army fire fighters. During the briefing, we at CAA again discussed the need for a study, but again determined that we were not the appropriate agency. By 21 September, when ODCSOPS informed us that snow was putting out the fires and the soldiers were redeploying, the Director, CAA, decided that the research opportunity would be missed entirely if we did not initiate a field study. With the concurrence of ODCSOPS, the CAA Director approved the hasty organization of a task force to study the Army forest fire fighters at Yellowstone National Park.

c. Since this is a unique opportunity for research that is seldom otherwise available, other Army agencies were invited to participate in the task force. They are: (1) US Army Research Institute (ARI) Systems Research Laboratory (SRL); (2) US Army Materiel Command (AMC), Laboratory Command (LABCOM), Human Engineering Laboratory (HEL) Behavioral Research Directorate; and (3) Walter Reed Army Institute of Research (WRAIR) Department of Behavioral Biology.

d. The fire fighting task force mission was to determine whether forest fire fighting has combat similarities and to collect as much data on the fatigue and stress of forest fire fighting as possible before the fires were completely out. From this data we will determine the major factors that cause fatigue or stress when fighting forest fires and decide whether the effects of forest fire fighting are actually similar to effects of actual combat. If the effects of forest fire fighting are similar to those of combat, we will then develop estimates of soldiers' combat. These estimates will be usable as data in the combat models.

2-3. **STUDY OBJECTIVES.** The following specific objectives were developed for the Fire Fighting Task Force (FIRE) Study:

a. Collect and analyze data on the fatigue and stress of forest fire fighting.

b. Determine the major factors that cause fatigue or stress when fighting forest fires.

c. Decide whether the effects of forest fire fighting are similar to effects of actual combat.

d. If we determine that the effects of forest fire fighting are similar to those of combat, we can then develop estimates of soldiers' performance during combat. So our final objective is to develop these estimates and assure that they are in a form that can be used as data in the combat models.

e. A secondary objective is to build an information base which can be used to design a more complete field study which measures the factors that cause forest fire fighting stress and the differences in soldier performance which are caused by those stresses.

2-4. **SCOPE.** The FIRE Study is limited to data collected from the Army soldiers who fought the forest fires in and around Yellowstone Park during August and September, 1988. Civilian fire fighters are very different in age, physical training, discipline, and other factors such as leadership, unit cohesion and morale. Army fire fighters in garrison probably do not have the same potential for continuous danger, do not usually have a need for working to the exhaustion point, and are not required to live in the austere conditions found in forest fire fighting.

2-5. **TIMEFRAME.** The average human body and the effects on it of emotions caused by perceptions of changing situations does not change with time-- certainly not within the years or months during which fielded equipment or Army organizations change radically. Therefore, these data should apply to all soldiers in the foreseeable future, or, at least, until the medical community actually develops the "chemical man" predicted by Richard Gabriel (Gabriel, 1987).

2-6. **ESSENTIAL ELEMENTS OF ANALYSIS (EEA).** Six major questions were formulated which follow directly from the study directives. Other related questions in which we are interested are listed with the EEA below.

a. **What are the major factors that cause stress while fighting forest fires?** Other related questions that should be answered here are: was fear one of the stresses? Are the factors the same as the factors that cause stress during an FTX?

b. **Does forest fire fighting cause combat-like stress?** Other questions that should be answered with this EEA are: if the stress is not clearly like that caused by combat, what other measures are needed for clarification? How does the amount of stress compare with that generated for laboratory or field experiments? Does the amount of stress vary by unit? If so, can the reason be identified?

c. **How does sleep loss affect soldier performance?** Examples of other questions involved in this are: how much do soldiers and commanders believe they sleep while fighting forest fires? Do they believe that their performance is affected by the sleep loss? Is the sleep loss severe? Does sleep loss vary by unit? If so, can the reason be identified? Can the sleep loss be equated to that envisioned for continuous operations during a war?

d. **How do other stresses affect soldier performance?** Examples of other questions involved in this are: do the soldiers or commanders believe that forest fire fighting stress affects their performance? Is the stress caused by forest fire fighting different for enlisted soldiers than for the officers? Is it different by unit? If so, why?

e. Is either the sleep loss or stress severe enough to continue to another phase which better measures performance on military tasks?

f. What lessons learned should be applied to another phase?

2-7. REPORT ORGANIZATION. Study methodology is provided in Chapter 3. Chapter 4 is a description of the job of forest fire fighting, including the tools used. Although much of the information in Chapter 4 may seem as if it is background information, it is data collected at Yellowstone. An understanding of the job of forest fire fighting at Yellowstone is necessary for an appreciation of the responses to the Essential Elements of Analysis which are provided in Chapter 5. The most important appendixes are Appendix D through Appendix G. The questionnaire developed by ARI is in Appendix D; the ARI analysis of that questionnaire is provided in the next appendix, Appendix E. The questionnaire developed by HEL is in Appendix F, and the HEL analysis of their questionnaire is provided in Appendix G. The description of forest fire fighting in Chapter 4 and the results presented in Chapter 5 are each a synthesis of the two analyses provided by the other agencies and information from the After Action Report.

2-8. SUMMARY. This chapter presented the background and development of the Fire Fighting Task Force Study, including the study objectives, scope and essential elements of analysis.

CHAPTER 3

METHODOLOGY

3-1. INTRODUCTION. This chapter describes the study methodology. The study team was composed of members from several agencies--each agency which provided a questionnaire also analyzed the data collected with that questionnaire. Therefore, some of this chapter may be redundant with parts of Appendix D (the ARI report) and Appendix G (the HEL report). However, for purposes of completeness, this chapter describes the total set of methodologies used in the FIRE study.

3-2. DATA COLLECTION METHODS

a. Questionnaires. The major sources of data for this study are two questionnaires--one developed by ARI and one developed by HEL. Although one combined questionnaire would have been preferable, the limited time available (approximately 1½ days) and the distance between agencies (about 2 hours' driving time) mandated that we either use items of interest to one agency only (a narrower range of data than desired) or use two questionnaires. We opted for the greatest possible range of data. A major problem with the use of two questionnaires is the requirement for two volunteer consent forms which are required, by Army regulations, for every questionnaire. Many subjects did not seem to understand the need for even one form and did not want to fill out a separate form for each questionnaire.

b. Questionnaire Respondents. Approximately 1,000 respondents, from four battalions of the 9th Infantry Division, plus aviators, aviation mechanics, and soldiers from the JTF Tactical Operations Center (TOC), completed each questionnaire. The majority of the respondents was enlisted soldiers.

c. Interviews. Although interviews can provide insights that help to understand data collected with more objective methods, interview data cannot be subjected to a rigorous statistical analysis. Therefore, although each team member had a microcassette recorder for interviewing subjects and interviewed as many subjects as possible in the time available, the total number of interviews is small, and the numbers of interviews are not distributed across respondent groups in the same proportion as the questionnaires. Interview data is used only for qualitative statements, not for any quantitative assessments.

d. After Action Report (AAR). The AAR, filed by the JTF, Yellowstone, at the end of the operation, provided objective data on arrival and redeployment dates, identification of which companies and batteries were included in each task force (TF), the assignments for each TF for each day by general locations, and lessons learned (Department of Defense, 1988). The information in the AAR proved to be a necessity for a complete understanding of data collected by other methods.

3-3. THE ARI QUESTIONNAIRE AND ANALYSIS

a. Questionnaire. The ARI researcher on the team, Dr. Donald Headley, has previously studied fatigue from sleep loss in continuous operations and

fatigue from wearing chemical-protective clothing. He developed a new questionnaire (Appendix D) specifically for this study. He designed it to measure the soldiers' attitudes toward the Yellowstone fire fighting experience and their personal assessments of their sleep loss, fatigue, and performance. The questionnaire also had questions to collect background information on the fire fight. This data is useful for more fully understanding the other data from this questionnaire and from the HEL questionnaire. Other questions, suggested by WRAIR about weight loss versus food and water availability (of interest to the medical community), are included. The focus of this questionnaire was specifically the soldiers who were involved in fighting forest fires on the ground rather than aviators, commanders, or soldiers in the JTF TGC and support units such as medical and aviation maintenance.

b. Analysis. Appendix E is the ARI report of the ARI analysis. The methodology portions are summarized below.

(1) Respondents. Ninety-three percent of the respondents, or 1,039 records, belonged to the five ground task forces identified in the AAR. This number represents nearly half of the 2,171 soldiers who were assigned to these task forces at Yellowstone.

(2) Data Groupings. Some companies and batteries were assigned to a TF other than their normal battalion during most of the deployment (another battalion had operational control, or OPCON). For analysis purposes, the records were sorted into the five ground task forces which had OPCON for the majority of the time according to the AAR. Most of the data tables in this FIRE Study Report are taken from the ARI analysis, and they include only the enlisted soldiers for these five task forces. Thirteen soldiers were removed because they said that they had other than fire fighting duties, i.e., a medic or in an operations center. Because they rarely performed fire fighting duties, officers were removed from most of these analyses. Soldiers were not removed from the analysis when they did not complete every question; when they left an item blank, they were removed only for the analysis of that item. For reasons of confidentiality, the task forces are coded as A through E, and the units that were included in these task forces are not identified. When ARI data are analyzed by rank, the enlisted data are divided into two groups--the first is enlisted grade E-1 through enlisted grade E-4; the other is enlisted grade E-5 through enlisted grade E-8.

(3) Statistics and Statistical Significance. Responses were coded and entered into a computer. They were analyzed using the SAS statistical software (SAS Institute, Inc., 1979). Categorical responses were tested for statistical significance by the chi square test. Distributions of continuous measures were tested for skewness. If significantly skewed, group differences were tested by the median test (Conover, 1971). Otherwise, they were tested by the unpaired t test or one-way analysis of variance. Differences are reported as significant only if the probability is .05 or less.

3-4. THE HEL QUESTIONNAIRE AND ANALYSIS

a. Questionnaire. Two team members, MAJ James King, PhD and Ms. Linda Fatkin, are from HEL. They, with other HEL researchers, have been studying stress with the objective of developing standard operating procedures for

assessing the effects of combat stress on tactical performance; the initial focus was on comparing physiological and psychological measures to identify the most useful in identifying severe, combat-like stress responses. For the HEL questionnaire for the FIRE Study (Appendix F), HEL team members selected items which they had used in previous studies on stress in Army soldiers and added background items. The previously tested items were the Multiple Affect Adjective Check List-Revised (MAACL-R, Zuckerman and Lubin, 1985) and rating scales which asked the soldiers to rate their perceptions of various experiences on a scale of 0 to 100. Although the MAACL-R has been used for clinical diagnoses of psychological disorders, it has been validated on both civilian and Army populations for measuring situational mood changes, i.e. respondents' cognitive and emotional reactions to perceptions of the situation and how it has, or is, affecting them. The rating scales that were used in previous studies and at Yellowstone have the referent situation changed for each study.

b. Analysis. The report provided by HEL of their analyses of their questionnaire response data is provided in Appendix G. The methodology used is summarized below.

(1) Respondents. The 1,007 respondents to the HEL questionnaire represent nearly one-half of the Army soldiers who deployed to Yellowstone to fight the forest fires. Some of the charts show a comparison of Yellowstone data to other situations where the same MAACL-R or rating scale was used. The subjects in these other studies were (1) spouses of patients undergoing abdominal surgery, (2) medical students taking an important written examination, (3) a control group for the first two, (4) airborne soldiers firing in a highly competitive situation, and (5) a control group of airborne soldiers firing in a noncompetitive situation.

(2) Data Groupings. As with the ARI data groupings, the data are broken into the TFs defined in the AAR, with companies and batteries assigned to the TF to which they were OPCONed for the greatest amount of fire fighting time. The same TF codes used in the ARI analysis are used in the HEL analysis. Since the MAACL-R and rating scales were appropriate for commanders as well as fire fighters, officers are included in the task forces in the analysis provided by HEL. An additional TF, Task Force F (TF F), is included in the HEL data. The soldiers in TF F are mainly aviators, aviation mechanics, and soldiers from the JTF. These soldiers did not directly battle the flames, slept and ate in the town of West Yellowstone instead of tent or spike camps, and did not perform the physically difficult fire fighting tasks. In this study, they are somewhat like controls. However, since TF F has a much higher percentage of officers than the other TFs, differences between officers and enlisted responses may cause greater differences between groups than would otherwise be found as differences between controls and fire fighters.

(3) Statistics and Statistical Significance. Except for a table showing number of respondents by rank, all HEL data is depicted in this report on bar graphs. The bar graphs allow the reader to visually compare the soldiers' perceptions of the Yellowstone experience with perceptions of other persons to different stressful situations (data collected in previous studies), or to compare soldiers' Yellowstone perceptions across task forces or rank. In the bar graphs in Appendix G, statistical significance is shown

by the vertical line topped with a horizontal line (a "hat") above each data bar. The length of the vertical line equates to the standard error. Picture each vertical line extending down into the bar so that an equal amount, plus and minus from the average score for the group (the top of the bar), is shown. When the top of one hat does not overlap with the upside down hat of another bar, the differences are significant. By comparing bars which represent small numbers of respondents with bars which represent large numbers of respondents, you can see that large numbers in the sample tend to reduce the size of the standard error. Therefore, smaller differences in bar heights (which represent average scores for the groups) will be significant when the number of respondents is large. In general, you will find significant differences between adjacent task force scores in the TF graphs and significant differences between adjacent rank scores in the graphs by rank. The charts in Chapter 5 and Appendix I are taken from the HEL data, but the charts have been rescaled so that all data for a rating scale or a MAACL-R mood measurement will be on the same scale. This makes it easier to compare TF scores with rank scores, and where available, with other scores from other situations. The computer software packages that are readily available at CAA do not provide the capability for drawing the standard error "hat." Therefore, the discussions will alert the reader when the differences are not significant.

3-5. QUESTIONNAIRE ADMINISTRATION. As should be expected in a field environment, no part of the questionnaire administration went as we would have planned it, except that care was taken to explain the purpose of the study, that data would be used only for statistical purposes, and that participation in the study was voluntary. Group sizes ranged from company to battalion. The locations ranged from the recreation area of a park lodge, to a gymnasium floor, and a theater. To avoid sequencing bias, we divided each group into two groups of approximately equal size. We gave the ARI questionnaire to one group first, and gave the HEL questionnaire to the other group first. When the respondents completed one questionnaire, they turned it in and were given the other. Since conditions were not conducive to the usual quiet atmosphere of questionnaire administration and we were dealing with large numbers of soldiers each time, the scene can only be described as sometimes chaotic. Soldiers did not always realize that there were two questionnaires, or when they did know that there were two, did not necessarily desire to complete both of them. Therefore, the number of enlisted soldiers in each TF in the ARI sample is different from the number of enlisted soldiers in each TF in the HEL sample. The ARI analysis did not include officers. The number in each sample is large--the smallest number of respondents on an ARI item is 62; the smallest number in the HEL TFs A through E (including the officers) is 93. The TF that is analyzed only by HEL, TF F, had 62 subjects.

3-6. THE CAA ROLE. CAA organized and lead the study team and developed the study objectives and essential elements of analysis (EEA). Although CAA decided which agencies should be invited to participate, suggested the topics that should be studied, reviewed the first draft of the ARI questionnaire, determined the schedule, and aided in the questionnaire administration and the later response coding, CAA team members performed none of the statistical analyses which are presented in this report. The CAA contribution to the analysis phase is the integration of the two separate reports from the research agencies for answering the EEA, preparing and giving the final briefings, and writing this report. A description of the sequence of events,

from the original conceptualization of the need for this study through the data collection phase, is provided in Appendix H. An analyst who is planning a similar study is encouraged to read Appendix H--it provides a flavor of a field study which is missing from the normal reporting of methodology (this chapter) and results (Chapter 5).

3-7. METHODOLOGY SUMMARY. This chapter provides the study methodology. The chapter described the data sources, the requirement for two questionnaires (and two volunteer consent forms), and the questionnaire administration (for examples of the questionnaires from ARI and HEL, the reader was referred to Appendix D and Appendix F, respectively). A major part of this chapter is a summarization of the methodology portions of two research reports, one from ARI and one from HEL, that are provided in Appendix E and Appendix G, respectively. In addition to these appendices, an analyst who may be thinking of a similar study is encouraged to read Appendix H to obtain a feel for the conduct of a field study.

CHAPTER 4

YELLOWSTONE FIRE FIGHTERS' DUTIES AND ORGANIZATION

4-1. INTRODUCTION. To fully appreciate the data analyses presented in Chapter 5, one must understand the soldiers' activities at Yellowstone. This chapter describes types of duties, work schedules, fire fighting equipment, locations of task force assignments, and the organization (relationship between the Forest Service and the military). Most of the information in this chapter is derived from questionnaire responses and interviews of soldier fire fighters. Specific information on task force assignments is from the JTF Yellowstone After Action Report (DOD, 1988). Although information on US Forest Service (USFS) fire fighting terminology, equipment, and schedules which is presented in this chapter came from questionnaire analyses, confirmation of USFS procedures came from informal interviews of USFS personnel at Yellowstone, a USFS report (USFS, 1984), USFS equipment procurement documents, and telephone conversations with USFS personnel. The information in this chapter will be useful as background material for the following chapter and for another study of military forest fire fighters. The terminology and procedures should aid in questionnaire design.

4-2. DEFINITIONS. There are some fire fighting terms that must be defined before we use them in describing a soldier's day at Yellowstone. They are:

Fuel reduction	Prior to fire reaching an area, cut out undergrowth and dead wood (AKA park beautification).
Cut line	Prior to fire reaching an area, cut a completely clear area that the fire should not jump across.
Mop-up	After fire, cut down dead trees (snags or widowmakers); put out small spot fires that remain.
Backburn	Prior to fire, set a controlled fire to make a clear area.
Hot line	Fight a blazing fire.
Structure protection	Probably the most intense firefighting.

4-3. A FIRE FIGHTING DAY AT YELLOWSTONE. The information presented in this paragraph was gleaned from a combination of interviews, comments written on the questionnaires, the JTF, Yellowstone After Action Report, and USFS reports. Information from interviews is thoroughly corroborated by comments written on the questionnaires and vice versa.

a. Sleep. We found that the USFS determines the number of hours of work versus sleep. They used previous ARI research reports on the effects of sleep loss and continuous operations to determine that all fire fighters should have 1 hour of rest or sleep for every 2 hours of work (the definition of work includes the time getting to the work area). Because there is

usually higher humidity at night, the Forest Service expects the fire can burn during the night without spreading very much while fire fighters rest. Therefore, the Forest Service scheduled an adequate amount of sleeping time for every crew. Except when absolutely necessary to mount a night patrol to watch for fire spread, scheduled sleep was 2200 until about 0500 the next morning.

b. Getting to Work. Just getting to the work site was sometimes very difficult and time-consuming. During interviews, we heard tales of waiting on the bus for several hours before it went anywhere, or starting to hike, then being brought back and loaded on a helicopter, only to get back off and hike after all. Although they usually hiked lesser distances, were bussed, or were flown to the work site, there were times when they hiked 10 or 12 miles in each direction. ("Hiked" is the term used by all soldiers of all ranks to describe the activity the Army calls "march." The terrain, described below, was not conducive to the conduct of a road march in formation.)

c. The Environment

- **Temperature.** It was August when the soldiers left Fort Lewis, and it had been a very hot summer. Some arrived with only their summer gear, only to find that nights are cold even in the summer because of the altitude. In September, they had the first snows of winter and some were not prepared. The Forest Service provided sleeping bags. There were enough that soldiers could use more than one when they were cold.
- **Terrain.** The terrain made hiking difficult. The soldiers were not used to it; they told us that physical training (PT) practice and PT tests had not prepared them for this. Inclines were sometimes so steep that the fire fighters used a fire line to hoist themselves up or to hold themselves in place while working. Most got blisters on the back of the ankle from the boot counters; they also blamed that on the terrain. The altitude ranged from about 6,600 feet in the town of West Yellowstone, Montana, to more than 10,000 feet in many areas of the park. Tourists are advised to not exercise when they arrive, as it takes several days to acclimate from sea level (the level of the 9th ID garrison, Fort Lewis) to this height.
- **Smoke.** At times the smoke was so heavy that it reduced the visibility so that the helicopters could not fly. The doctors estimated that each day at Yellowstone, the soldiers probably inhaled smoke equivalent to smoking four packages of cigarettes, and that it may take as long as 6 months for their lungs to return entirely to normal.

- **Wind.** At Yellowstone, the wind seemed an ally of the fire. It frequently blew 50 to 60 miles an hour, sometimes more, causing the fires to jump most of the fire breaks that had been painstakingly built by hand--mechanized equipment such as bulldozers and tractors are not permitted in Yellowstone National Park, even during a fire. Nor could the fire be ignored at night as expected by the Forest Service. Because the wood was so dry (less moisture content than most kiln-dried wood) and the winds blew so hard (up to 80 miles per hour), there had to be fire patrols many nights. The soldiers who patrolled were given a sleep period during the daylight hours.

d. Tasks and Equipment. Nearly all of the soldiers in task forces A through E were assigned to physical labor that easily fits the Army category of "very heavy." Table 4-1 shows the percentage of these soldiers who listed each of the most common equipment items. Since the soldiers were asked to list all of the equipment they used, the total is greater than 100 percent. Most of the equipment items are extremely tiring to use. The drawings in Figure 4-1 are from procurement specifications. You can see that the Pulaski has a handle about 30 inches long. The McLeod has a 48-inch handle. A newer tool than the Pulaski or McLeod, called the Combi (not shown), is a redesign of an Army trenching tool from the 1950s. Although the Combi tool has a longer handle (the literature did not say how much longer), there are not yet very many in the inventory, so it was available to very few of the soldiers. The back pump is a 5-gallon water bladder, worn on the back and used on spot fires. Because of the health dangers from dehydration, the soldiers had to carry drinking water as well as their tools.

Table 4-1. Equipment Most Frequently Used at Yellowstone by Enlisted Soldiers

Equipment	Percent by task force ^a					All enlisted
	A	B	C	D	E	
Shovel	28	28	29	26	34	30
Pulaski	25	27	25	22	31	27
McLeod	19	16	15	20	21	18
Combi tool	0	11	0	9	1	4
Back pump	14	8	12	8	7	9
Chain saw	5	5	10	3	2	5
Others	9	5	9	12	4	7

Source: ARI.

^aTask forces are coded to protect the privacy of the soldiers. The codes were randomly assigned to the task force names used in the after action report.

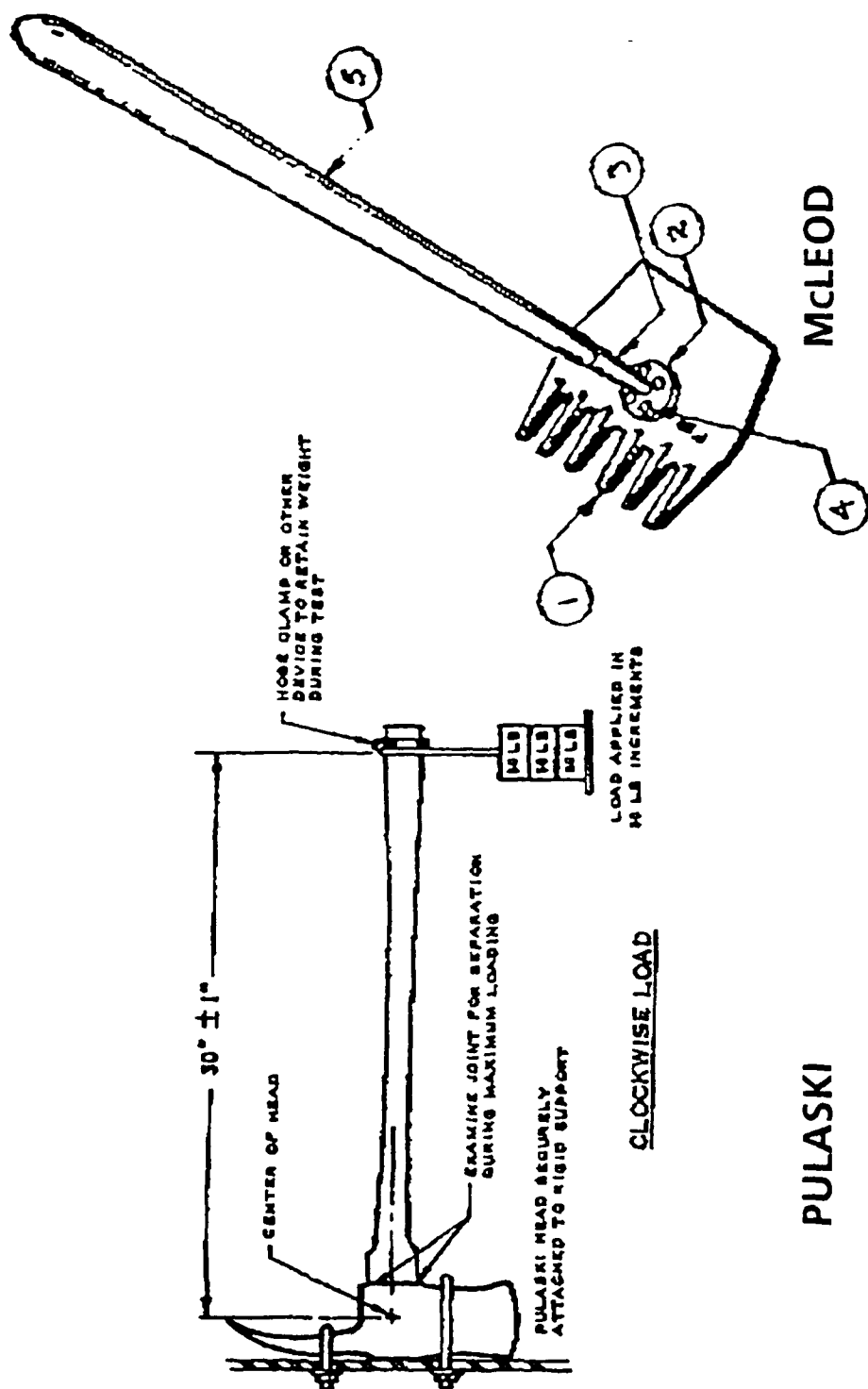


Figure 4-1. Weapon Drawings From Procurement Documents

e. **The Work.** Table 4-2 shows the types of work the soldiers listed most often as the duties that they performed in the fire area. Again, because they were allowed to list as many as applied, the total will add to more than 100 percent. The After Action Report seems to be more specific about the kinds of duties than were the soldiers. The soldiers seemed to frequently call everything "mop-up" and seldom used the term "structure protection." Since mop up includes tasks similar to others shown such as fighting small spot fires, cutting down snags and clearing undergrowth, it is likely that many assumed that it was mop up when it was given a different name by the leaders who assigned the crews.

Table 4-2. Work Most Frequently Performed at Yellowstone by Enlisted Soldiers

Activity	Percent by task force					All enlisted
	A	B	C	D	E	
Cutting fire breaks	32	22	35	32	35	33
Mop-up	24	30	26	24	25	24
Back fires	16	4	4	16	8	8
Cutting down snags	5	6	12	6	7	7
Rolling and unrolling hoses	9	6	13	9	5	8
Fuel reduction	6	21	3	2	3	6
Others	8	11	7	11	17	13

Source: ARI.

f. **Organization.** The Boise Interagency Fire Center (BIFC) had overall control of the forest fire fight. The Forest Service determined where the crews would go and how many crews were needed in each location; the military determined which soldiers were in each crew. Each military fire fighting crew was led by an experienced civilian fire fighter who provided the required expertise in fighting fires. BIFC provided all Class I (food and water) and Class II (fireproof clothing, sleeping bags, firefighting equipment) and Class III (POL (petroleum, oils, and lubricants)) materials. These were usually provided by contract with civilian organizations.

g. **Safety Considerations.** Both the Forest Service and the military consider human life much more important than trees and grass. Therefore, when there was a choice between fighting the fire and safety of personnel, personnel safety was always the option chosen, i.e., the fire was allowed to win battles when necessary to protect the fire fighters, whether civilian or military. As a result, there were very few serious injuries and only one death (a civilian fire fighter) during the month that both the military and civilians fought fires in and around Yellowstone. Providing food and water to the soldiers was more important than dropping flame retardant on the flames. Although safety considerations are important during wars, the military would never allow the enemy to win a battle to protect a few soldiers (maybe they would if the entire unit was likely to be lost). So in this respect, the fight at Yellowstone was not representative of combat.

4-4. TASK FORCE ASSIGNMENTS. Information in this paragraph is from the JTF, Yellowstone After Action Report. All units were in the fire area for 24 or 25 days. Figure 4-2 is a schematic which shows the location of the fires. For all battalions, the first day or two was spent training with the equipment on a cold line. The AAR told us how many, but not which specific crews, companies or batteries were assigned to what types of duties each day. Rarely was an entire task force assigned to the same type of duty, so we have only an upper limit on the number of days that any one soldier could have been assigned to hot lines (fire), structure protection (fire), mop-up, cutting line or fuel reduction duties. Table 4-3 is a summary of the number of days that at least one crew in each of the task forces faced actual fires; the task forces have been coded so that the exact identity of the unit will not be known. All data has been recoded using the identifiers of A through E to represent the task forces. The soldiers were working nearly every day they were at Yellowstone. The days not recorded in this table were spent on a cold line, cutting a fire break, performing fuel reduction activities, standing down, or moving to a different location.

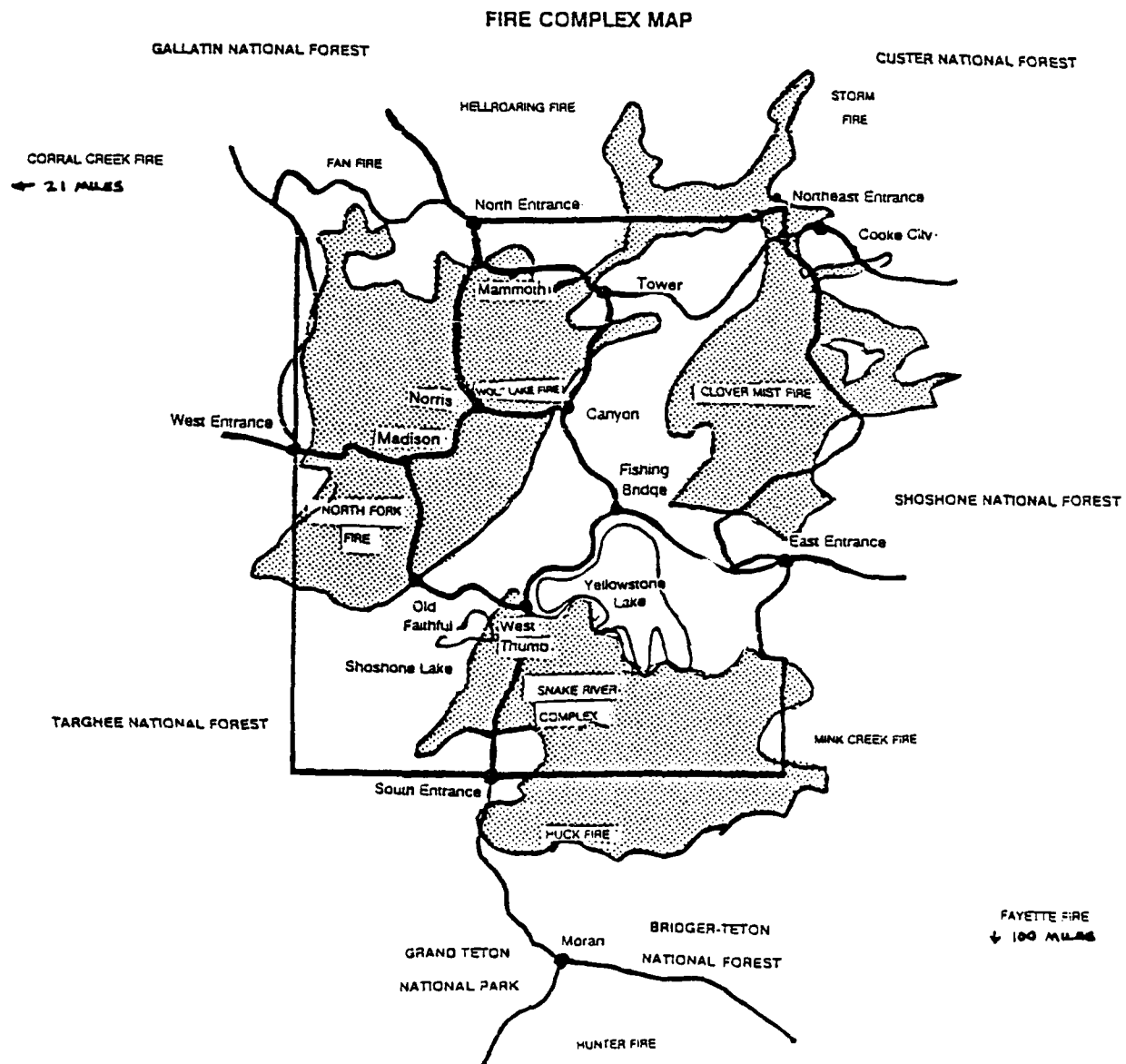


Figure 4-2. Location of Major Fires at Yellowstone

Table 4-3. Fire Fighting Days by Task Force

Activities	Number of days by task force				
	A	B	C	D	E
Hot line	7	--	6	4	6
Structure protection	7	--	5	2	4
Set backburns	--	--	2	--	1
Total fire fighting days ^a	10	--	13	6	8

^aTotal days is sometimes less than the sum of the column. Because task force crews had different duties each day, part of a task force may have been assigned to a hot line while a second crew from the same task force was protecting a town in another area. Total days is actually an upper limit.

4-5. CHAPTER SUMMARY. This chapter described a fire fighter's day at Yellowstone, the equipment used, and the relationship of the USFS and the military. In general, we found that soldiers performed physically laborious work on most of their days in the area, actually fought flames on only a few of those days, and were usually provided an adequate length of time for sleeping. Although military leaders provided the usual command leadership, the overall control of the forest fire fight was provided by the USFS Boise Interagency Fire Center, and each fire fighting crew was led by an experienced civilian fire fighter.

CHAPTER 5

RESULTS

5-1. **INTRODUCTION.** This chapter provides the responses to the essential elements of analysis (EEA) and data to substantiate them. In all tables and charts which give the results of data analyses, the task forces are coded for reasons of privacy of the soldiers. They freely responded to our questionnaires with the expectation that they and their unit would not be identifiable.

5-2. **ESSENTIAL ELEMENT OF ANALYSIS 1.** What are the major factors that cause stress while fighting forest fires? We identified a wide variety of stressors at Yellowstone. They ranged from traditional combat stressors, to stressors that may not usually be considered combat stressors (but the study team feels are usually found in combat and should be considered stressors), to unique-to-Yellowstone stressors. The latter stressors may provide useful information for a joint or combined environment. The Yellowstone stressors are described below, in qualitative terms, rather than quantitative. Identification of the stressors came from interviews and comments written into both questionnaires.

a. Most traditional combat stressors exist, but usually in a different form.

- Fatigue is thought to be the major stress in combat, and sleep loss from continuous operations is expected to be the major component in the next major conventional war. At Yellowstone the major stress was fatigue, but its major component was physical exertion, not sleep loss.
- Fear of injury or death is present in combat and was present at Yellowstone. At Yellowstone, the major components of this fear were the fire and the snags, or widowmakers. They are inanimate, but real, unpredictable and dangerous. The other fears are also not usually present in combat, but could be--grizzly bears and snakes. As well as having to post someone for "snag watch" while the others worked, they mounted a "grizzly watch" at all times.
- Terrain will frequently cause physical stress in combat. The soldiers said they were not physically prepared for the difficulties of this terrain. Yellowstone National Park and the surrounding area is mountainous terrain, as is Korea, many areas of Europe, and Third World areas where low intensity conflicts may be fought. Hiking to work sites and performing the required work on steep slopes intensifies the physically fatiguing aspects of fire fighting. The time required for hiking the required distances from base camp in this terrain sometimes necessitated sleeping in "spike" camps with food and water airdropped.
- Temperature extremes, another traditional combat stressor, was certainly present at Yellowstone, and some of the soldiers were unprepared.

- At first, precipitation was not a stressor at Yellowstone. However, the winds were probably as difficult to work in as would have been rain. The later precipitation, snow, in September actually kept one of the task forces from getting to the job site, so it was definitely a stressor.
- Other traditional combat stressors are noise, crowding, NBC (nuclear, biological, and chemical), and darkness. In general, these were not problems at Yellowstone.

b. Stressors found at Yellowstone, but which are not usually listed as combat stressors, are austere conditions and a generally hostile environment. These should probably be included with the traditional stressors.

c. Other stressors which should be sometimes, if not always, expected in combat are uncertainty about today and the future, boredom or a lack of feeling useful, high altitude, and breathing smoke and ash.

d. Stressors which seemed to be unique at Yellowstone, but which might be a useful simulation of combined operations, are working with civilians and inexperience with equipment. Every military fire fighting crew was led by an experienced civilian fire fighter. By the end of the 3 to 4 weeks spent together, the military unit usually accepted the civilian as one of their members, and it was a cohesive unit. Nevertheless, there were many comments about the civilians' inability to work as long or as hard as the military, the "big bucks" the civilian fire fighters earned as their basic pay, and the number of overtime hours the civilians earned, while the military lost pay because food and shelter were provided.

5-3. EEA 2. Does forest fire fighting cause combat-like stress? Forest fire fighting does cause combat-like stress. However, the stress levels that we found are less than we would expect to be found in combat. This is more fully described below. The response to this question is a combination of qualitative and quantitative. The quantitative part comes from an assortment of stress measurements from the MAACL-R and the rating scales on the HEL questionnaire. The qualitative portion comes from comments on the questionnaires, the interviews, and from the responses to the question on the HEL questionnaire, "How does this compare to your idea of a combat situation?"

a. Quantitative Measures

(1) The data shown in Figure 5-1 are from an item (see page F-6) that asks the respondents to rate how stressful they consider a specific event, on a scale of 0 to 100 (0 represents no stress; 100 represents the maximum possible). The graph labeled "situation," graph a, shows the average rating for all Yellowstone respondents in the bar on the right for comparison with several other events. The bar on the left, SURG, is spouses of patients undergoing abdominal surgery. The next bar, EXAM, is the average rating by medical students taking a major written examination. SECN is the average rating by the surgical/examination control group. SS stands for Salvo Stress Study. In the Salvo Stress Study, HEL studied airborne soldiers firing at targets. One group had little or no stress and is the control group. The control group practiced firing at targets in a noncompetitive environment.

The bar labeled SSCN depicts the average rating by the airborne control group. The final bar (SSCM) is the average rating by airborne soldiers firing at targets, but in a highly competitive marksmanship setting. Yellowstone soldiers, in the aggregate, rate the experience a little lower (not significantly) than the abdominal surgery spouses. However, the data by task force shows that there is a significant difference between TF A and TF C and between each of them and TF B, TF D, and TF E (the latter three are not significantly different from each other). TF F is significantly different from all of the others. There are no significant differences between enlisted soldiers in grades E-7 and E-8 (E7-8), warrant officers (W1-4), captains (O3), and majors and lieutenant colonels (O4-5). However, enlisted soldiers in grades E-1 through E-3 (E1-3) rate the event significantly higher than any others; enlisted soldiers in grades E-4, E-5, and E-6 (E4-6) are significantly lower than E1-3, but significantly higher than all of the other groups. Lieutenants (O1-2) rate the experience significantly lower than all of the other groups.

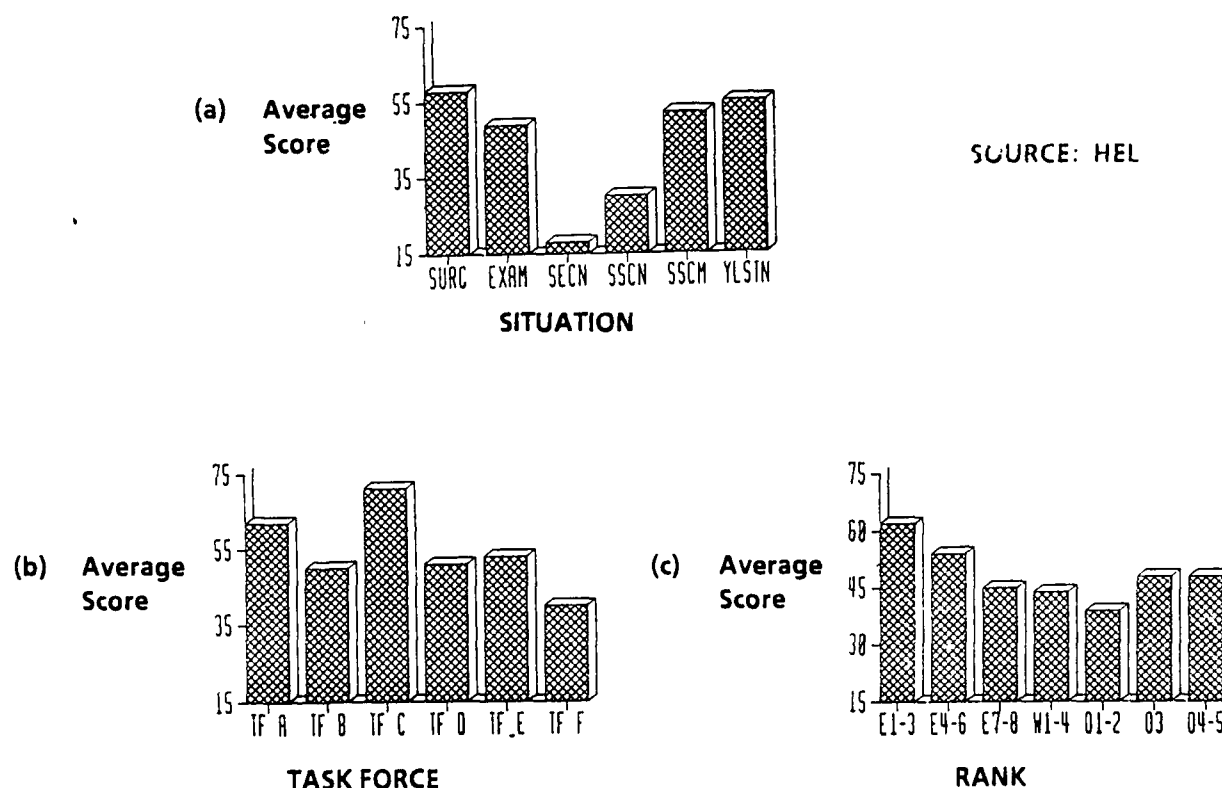


Figure 5-1. Ratings of Event Stress
(possible range is 0 to 100)

(2) There is one task force which is clearly different from the rest (TF F) in Figure 5-1; it is not a specific unit. Instead it is a collection of soldiers who were either in the town of West Yellowstone, Montana, throughout their stay in the area or who were assigned to some other job that

clearly did not require that they fight the forest fires. The difference is partially explained by the breakout by rank, Table 5-1, which shows that half of this "task force" is officer or warrant officer, and only one soldier is in the E-1 to E-3 group. Officers rated the Yellowstone experience as much less stressful than did the lower enlisted ranks (the majority of the respondents in the other task forces). From interviews, we know that many of the warrant officers in this group were aviators who had been in West Yellowstone about 2 weeks, watching television in their motel rooms, eating, writing letters, doing anything they could find to do, but not flying and not working at any other job. Their only stress was not being able to do as much flying as they would have liked.

Table 5-1. Task Force Profiles by Rank

Task force	E1-E3	E4-E6	E7-E8	W1-W4	O1-O2	O3	O4-O5	Total
A	66	90	3	0	8	4	1	172
B	28	125	15	4	13	3	0	188
C	53	88	5	0	4	2	0	152
D	27	52	1	0	8	2	0	90
E	65	135	15	1	26	9	2	253
F	1	29	1	20	3	7	1	62
Total	240	519	40	25	62	27	4	917

Source: HEL.

(3) The rest of the difference between task forces seems to be explained by the number of days they spent near fires on hot lines, protecting structures, and setting and controlling backburns. When the total number of days shown earlier (in Table 4-3) is charted in bar graph form, as in Figure 5-2, you find a pattern very like Figure 5-1. In fact, the rest of the bar graphs in this report and the appendices show this same pattern, whether they came from a rating scale of 0-100 or from the MAACL-R. TF C and then TF A will be higher on the negative measures and lower on the positive measures than the other task forces. TF F is always the opposite of TF C. Although TF B did not actually fight fires, it was required to work as many days as the other TFs (A, C, D, and E), and the duties they were assigned were as physically strenuous as those given to the other TFs. TF B is included in all analyses and may be considered somewhat like a control group

who had the physical stress but not fear. TF F had neither physically demanding work nor fear, and is also somewhat like a control group. TFs B and F are different from true control groups. TF B may have experienced a negative aspect not received by the other TFs--some felt their work was "busy work" which led to a feeling of uselessness and boredom. TF F had a unique rank distribution. A "typical" pattern exists within the rank charts--the lower ranks of the enlisted soldiers are always very different from the officers. A large part of the rank difference is probably explained by the difference in duties.

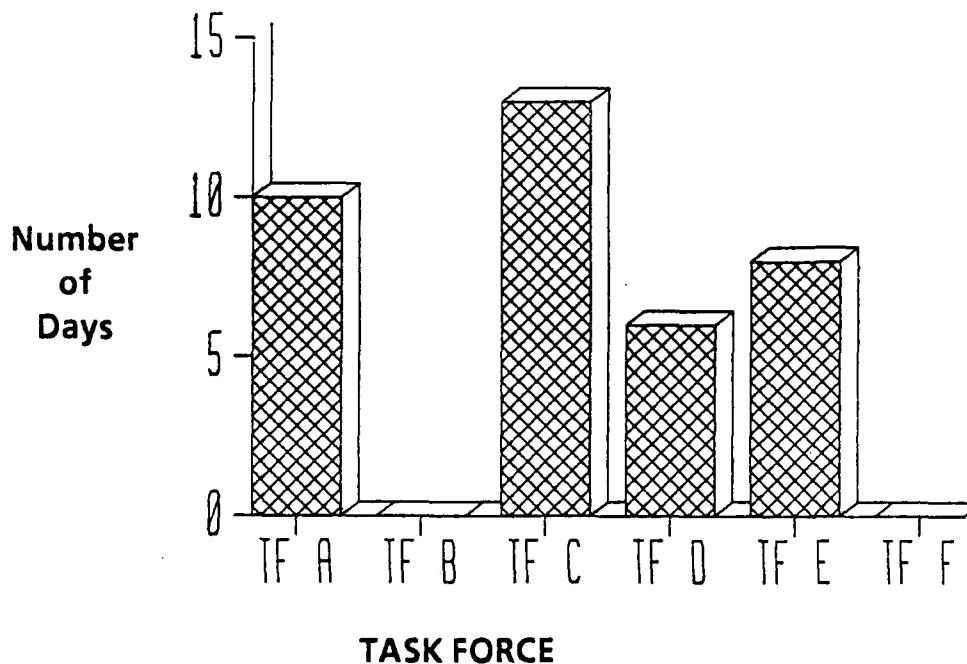


Figure 5-2. Fire Fighting Days by Task Force

(4) HEL also asked the soldiers to rate how life-threatening their duties were. As you can see from Figure 5-3, the expected patterns appear. TF C felt their duties were much more life-threatening than the others, and TF F is at the opposite end of the scale. Also, there is the expected variation between the lower enlisted and all officers. The battalion commanders, aviators, and officers in the JTF TOC (TF F) obviously did not feel very much at risk. Although TF B did not fight fires, they felt at risk from snags or widowmakers, dangerous equipment, grizzly bears, and snakes.

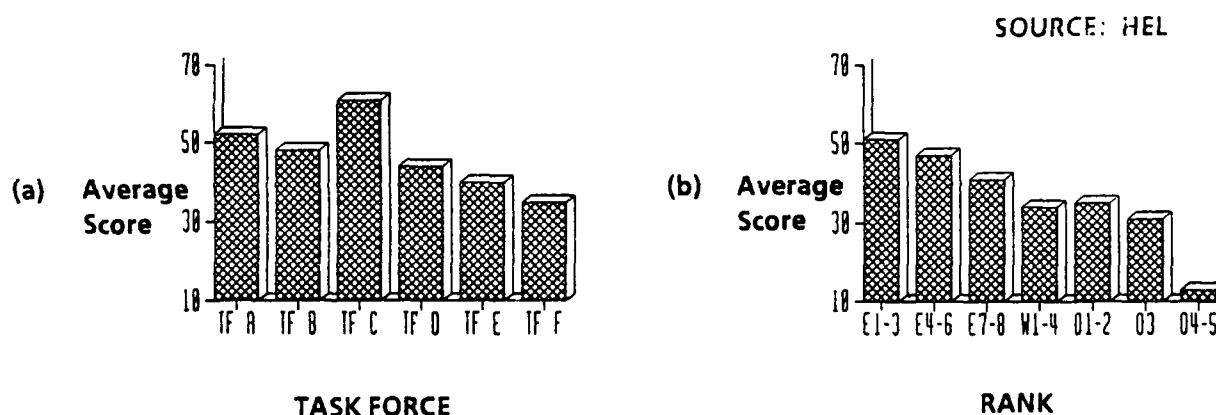


Figure 5-3. Life-threatening Rating
(possible range is 0 to 100)

(5) ARI asked the soldiers whether they felt their personal safety was ever threatened by fire, and if so, why. As you can see from Table 5-2, the largest percentage who responded yes, nearly two-thirds, was task force C followed by task force A. Since a preliminary look at the data showed that officers and TF F members were clearly different from the majority, the ARI analysis did not usually include either group; the data in Table 5-2 are enlisted soldiers only. Many soldiers ignored the "by fire" part of the question. In addition to fire-related reasons such as walls of fire, flareups, unseen hot spots, and thick smoke, they told us that equipment, particularly axes (including Pulaskis) and chain saws, snags, widowmakers, terrain, and fatigue all threatened their safety on the fire lines.

**Table 5-2. Personal Safety Threatened by Fire
(enlisted soldiers only; TF A through TF E)**

Question	Percent by task force					All enlisted
	A	B	C	D	E	
Percent yes	62	46	64	53	49	55
Percent no	38	54	36	47	51	45

(6) The ARI questionnaire asked the soldiers whether they thought their ability to work decreased as the number of days on the fire line increased and gave them a check list of reasons that might apply plus space to write additional items. Of those who felt their work ability did decrease (60 percent), many seemed to feel that the physical labor wore them out the most, with lack of sleep being the next most important reason. Only 5 percent of those who responded "yes" wrote in reasons; the rest used the check list. Fifty-nine percent checked or wrote in at least one reason; the average number of reasons was 2.0. Four of the items in the check list drew 90 percent of the reasons, as shown in Table 5-3.

Table 5-3. Ability to Work (enlisted soldiers only; TF A through TF E)

QUESTION: Do you feel that your ability to do work decreased as the number of days on this job increased?

Reason	Percent
"The type of work I did wore me out"	38
Lack of sleep affected by physical stamina"	24
"There weren't enough rest periods"	17
"Lack of sleep affected my ability to think clearly"	13
Others	8

Source: ARI.

b. A Qualitative Measure. When HEL asked the soldiers to compare the fire fighting experience with combat, 40 percent stated they could not compare the fire fighting experience with combat; the other 60 percent provided the factors shown in Figure 5-4. Many of these factors are traditional stresses that should be expected in combat--continuous operations, unpredictable and dangerous enemy, unfamiliar terrain, physical stress, and

communication problems. Some of the others--leadership requirements, deployment process, and separation from family--may be stressors, but we do not yet know how significant they may be. Teamwork, unit integrity, and discipline are thought to enhance the soldiers' capability to withstand the stress of combat. In general, the Yellowstone fire fighting experience seems to have similarities to combat. It certainly shares some of the same factors, but how similar, quantitatively, we cannot say from these qualitative data.

- About 40 percent of the soldiers stated they could not compare the fire fighting experience with their knowledge or idea of combat
- The 60 percent who did identified the following common factors:
 - Deployment process.
 - Separation from family.
 - Need for teamwork and maintenance of unit integrity.
 - Managing individual differences in stress responses.
 - Need for discipline (following orders without question).
 - Continuous operations--alternating intense activity and boredom.
 - Fire as an unpredictable and dangerous enemy.
 - Unfamiliar terrain--limited escape routes and dangerous animals.
 - Leadership requirements.
 - Physical stress--fire fighting duties and 10-14 mile marches.
 - Problems in communications down the chain of command.

Source: HEL.

Figure 5-4. Comparison of Firefighting with Combat

c. EEA 2 Summary. In response to this EEA, we can say, "Yes, the stress of forest fire fighting is combat-like, but the yes must be a qualified yes." For many reasons, the level of stress that we were able to measure is probably not as high as would be expected in combat. With better timing of the measurements, targeting of the respondents, and a better questionnaire, it is probable that the stress levels we would find would be higher than those shown here. Although we do not expect that we will be able to find fear that equates to that of combat, these preliminary data suggest that further study, with preplanning and arrival at the appropriate time, will produce measurements that will provide much more information about stress and soldier performance that should be useful in preparing and planning for combat. The results for this EEA are summarized as follows:

- The danger caused by fire and other threats to personal safety that are found in forest fire fighting is usually less than combat danger. This is partially due to the safety requirements imposed by both the Forest Service and the Department of Defense. Both agencies feel that fire fighter lives are always more important than forests and meadows which can regenerate their vigor, sometimes within weeks.
- The sleep loss suffered in forest fire fighting is usually less than is expected during periods of intense combat. This is true because of the Forest Service insistence that adequate sleep periods are scheduled. It would be interesting for the purpose of this avenue of study if the Army were allowed to set its own sleep standards for the next forest fire. If present training exercises can be used as a model for the schedule the Army might be expected to devise, the Army would probably allow little time for sleep. We would be able to collect the data we need on results of lack of sleep on real Army operations. However, many soldiers would probably be at much more risk to their safety than they were in the Yellowstone operation.
- The physical stress of forest fire fighting may be greater than combat. The physical stress is greater than that for which the soldiers train and are tested for with the PT test. It is possible, however, that the PT standards are too low for both combat and forest fire fighting. If so, forest fire fighting could be used as a surrogate for combat in determining whether different PT regimens increase strength and stamina.
- Even though both danger and sleep loss stress are minimized, the stress levels of forest fire fighting are higher than in any of the other situations measured to date. Although we believe that the physical stress may be greater than in combat, we also believe that because of fear, specific soldiers, in particular locations may have experienced stress levels so high that they would be impossible to duplicate in a laboratory or field exercise environment. Forest fire fighting provides a unique opportunity to measure and compare performance levels with the amount of stress caused by a variety of stressors.

5-4. EEA 3. How does sleep loss affect soldier performance?

a. This was one of the main EEA that we had hoped to answer when we decided to collect data on soldier stress and performance in the Yellowstone forest fire fight. However, since the fires were nearly out when we arrived, we were not able to collect objective data on sleep loss with the WRAIR activity monitors (actigraphs). There are questionnaire techniques which could be used to better quantify subjective judgments, particularly if we were able to better identify exactly which soldiers were the ones who did the night patrols and who fought the fires at Old Faithful at night.

b. For now, Army Field Manual, Continuous Operations, FM 22-9 is still the best, most easily accessible data source for sleep loss effects. However, the laboratory research reflected in FM 22-9 leads one to believe that soldiers can continue to fight in a degraded mode for several days. Some of the data collected on the ARI questionnaire suggests that this

expectation may not be true. As shown in Table 5-4, 88 percent of the soldiers had participated in exercises which required long work hours, with an average length of 12 days. The number of hours that they felt they could continue physical work is amazingly consistent across task forces--32 hours. They seem to be saying that they know they can go without sleep one night and continue to work during the next day and part of the night. If you assume that they woke up at 0600, then 32 hours later is 0200 the next morning. It is also the beginning of the diurnal cycle (0200 to 0600) which medical research tells us is the most difficult time to be required to be awake--bodily functions are at their slowest.

**Table 5-4. Previous Experience in Extended Workdays
(enlisted soldiers only; TF A through TF E)**

Question	Percent by task force						All enlisted records
	Response type	A	B	C	D	E	
Previous military experience in long workdays?	% Yes	92	83	86	93	91	88
Longest previous continuous mission	Days	13	13	11	11	13	12
Estimated continuous physical work	Hours	32	32	30	32	35	32
Got tired to point physical work was affected	Days	8	6	8	7	7	7

Source: ARI.

5-5. EEA 4. How do other stresses affect soldier performance? Over time, the soldiers' ability to work decreases. This may be caused by a combination of both physical and mental stress, as discussed below.

a. They started tired. Table 5-5 shows the enlisted soldiers' responses by task force for several questions from the ARI questionnaire. Apparently, the deployment process itself is tiring. The fires progressed so rapidly that the 9th ID had very little advance notice. In addition to preparing for deployment, fire fighting instruction was provided at Fort Lewis by the Forest Service. The deployment process may be an area we should study further. When they started their Yellowstone duties, three-fourths or more of the soldiers from every task force were somewhat or very tired. Tired soldiers are not 100 percent productive or efficient soldiers. Since deployment was defined by the soldiers as a factor similar to combat on the HEL

questionnaire (see Figure 5-4), developing a method for deploying the soldiers without tiring them might provide a significant edge in battle. The number of days before they tired to the point that they felt their physical work was affected averaged 7.2 days (Table 5-4). TF B, the TF that felt their work was useless, seemed to feel it first, while the soldiers who felt they were really needed (TF C, then TF A) lasted the longest--34 and 36 days versus 19 to 30 days.

**Table 5-5. Selected Questions by Task Force
(enlisted soldiers only; TF A through TF E)**

Question	Percent by task force						All enlisted records
	Response	A	B	C	D	E	
How tired at start?	Somewhat or very tired	75	82	77	78	79	78
Fire fighting physically harder than MOS tasks?	Yes	95	97	86	80	76	86
Ability to work decreased over time?	Yes	65	53	75	44	58	60
So tired someone became dangerous?	Yes	36	28	34	19	30	29

Source: ARI.

b. **The work was tiring.** The percentage of soldiers (Table 5-5) that felt that forest fire fighting was physically harder than their military occupational specialty (MOS) tasks is striking. As expected in a combat division, most of the soldiers are in combat specialties. These specialties are rated as "very heavy" jobs for purposes of counseling new recruits on specialty choices (the scale is light, medium, moderately heavy, heavy, and very heavy). Yet most felt their ability to work decreased over time; more from TF C felt that way (followed by A) than the other TFs. Nearly one-third felt that they or someone around them became so tired that they became dangerous to themselves or to those around them (again, more felt that way in TF C and TF A). This table shows interesting differences between TF D and TF E on the last two questions. We do not know enough about these two task forces to discern the reason, except that TF E seemed to have more fire fighting days than TF D. Data for TF B tends to fall between them, however, so fire fighting days may not be the discriminator.

c. **They lost weight.** The soldiers' estimate of their weight change on the ARI questionnaire is shown in Table 5-6. Because the number of pounds changed includes zeros for those who indicated no change (about one-third), of the two-thirds who lost weight, the average is actually much more than is shown--a substantial amount of weight to lose, especially when you consider that the Forest Service was supplying about 6,000 calories per day via private catering services. Since two of the task forces had been back at Fort Lewis about 10 days by the time they filled out this questionnaire, we assume that many may have had an opportunity to weigh. The average for each of these task forces is in the middle range, neither the lowest nor the highest. At this rate of change, our lean and mean soldiers would quickly become skinny soldiers. Some of the reason for feeling they lost capacity for physical work may have been from a feeling of weakness, either from losing weight or from becoming dehydrated. One item we will want available for further phases is a good scale with which to weigh them.

**Table 5-6. Estimated Weight Change
(enlisted soldiers only; TF A through TF E)**

Measure	Response type	Task force					All enlisted records
		A	B	C	D	E	
Average estimated weight change	Pounds	-5	-7	-6	-5	-4	-6
Indicated lost	Percent	57	83	67	61	54	66
Indicated no change	Percent	42	16	33	38	41	32
Indicated gained	Percent	1	1	0	1	5	2

Source: ARI.

d. Junior enlisted feel somewhat differently than NCOs. Table 5-7 shows responses to questions from the ARI questionnaire that we have looked at before, but separated by rank instead of by task force. As you can see, there are both similarities and differences. The largest differences are in the questions about whether the soldiers' ability to work decreased over time and whether their work activities were well organized by the supervisor. ARI looked at the officer responses to the latter question ($n = 94$), and found that 68 percent of the officers felt that activities were well organized by the supervisor, significantly different from either enlisted group.

Table 5-7. Selected Questions by Rank
(enlisted TF A through TF E)

Question	Response	Percent by rank		Significant
		E1-E4	E5-E8	
How tired at start?	Somewhat or very tired	79	77	No, Chi square < 1 , $df = 1$
Fire fighting physically harder than MOS tasks?	Yes	88	86	No, Chi square < 1 , $df = 1$
Ability to work decrease over time?	Yes	64	49	Yes, Chi square = 15.6, $df = 1$, $p < .001$
Activities well organized by supervisor?	Yes	43	56	Yes, Chi square = 10.0, $df = 1$, $p < .005$
Personal safety threatened by fire?	Yes	57	50	No, Chi square = 3.3, $df = 1$, $p < .10$
Perceived stamina	Hours (median)	24	36	Yes, Chi square = 26.0, $df = 1$, $p < .001$
Estimated weight change	Pounds	-5	-6	No, $t < 1$, $df = 768$
Number of respondents		588	242	

Source: ARI.

e. **Soldiers are depressed.** Figure 5-5 shows the situational depression ratings for Yellowstone compared with other situations (chart a), by task force (chart b), and by rank groups (chart c). Depression tends to be associated with a fear of failure. The differences are significant except between Yellowstone and surgery (SURG) and between the marksmanship groups (SSCN and SSCM). The ratings came from the MAACL-R on the HEL questionnaire. For the lower ranking enlisted soldiers, the Yellowstone experience seems to be associated with very high depression levels. However, we do not know whether these soldiers were depressed before they left Fort Lewis--perhaps airborne soldiers (SSCN and SSCM, chart a) and officers are not as depressed as the average soldier, but most soldiers seem to be more depressed than nonsoldiers (see the surgical and exam control group, SECN). Even the JTF TOC officers and the warrant officer aviators, who we think of as our control group, are higher than the nonsoldier controls (SECN). We believe that the depression depicted here is a result of the soldiers' reactions to the fire fighting experience--the pattern on the task force chart is the same as the one for fire fighting days (Figure 5-2). So far, we do not know what the depression rating might be for a soldier who develops combat fatigue (becomes a neuropsychiatric casualty). Since scores caused by stressful events tend to decay with time, it is interesting to speculate how close some of the E1-E3 group may have been during the fire fight. These are the highest depression scores that HEL has found.

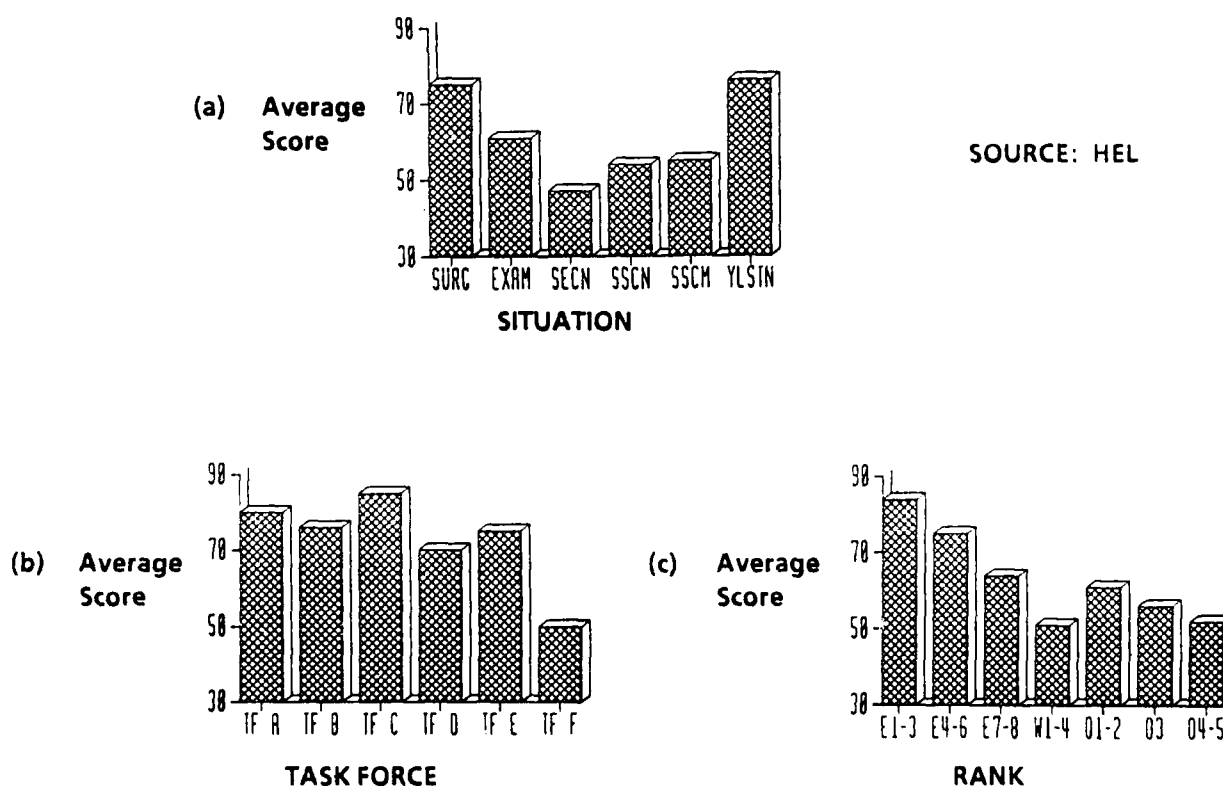


Figure 5-5. MAACL-R Depression Ratings (possible range is 40 to 338)

f. **Soldiers are hostile.** Competition, whether in a marksmanship contest or with an enemy (in this case, the fire), seems to breed a feeling of frustration, or hostility as measured by the MAACL-R. This may be good; combat accounts imply that soldiers need to feel hostile when they face the enemy. Figure 5-6 shows that the competitive group of the marksmanship study (SSCM) had average hostility ratings on the MAACL-R that were nearly as high as the average Yellowstone ratings. Again, we see the expected patterns in both the task force chart and the rank chart. Since TF B performed the most "park beautification" duties, it is not surprising that they were feeling hostile, i.e., they may have been feeling frustrated about spending their time doing work they thought could have been done by anyone rather than fighting fires as they expected to do. Is there a measure of how much hostility is enough or too much? Do the officers know how much difference there is between the junior officers and the senior officers? And between the officers and the enlisted? Do the senior NCOs realize how the junior enlisted are feeling--both depressed and hostile? Again, we do not know the answers. With more measures in additional situations, some of them may become more clear.

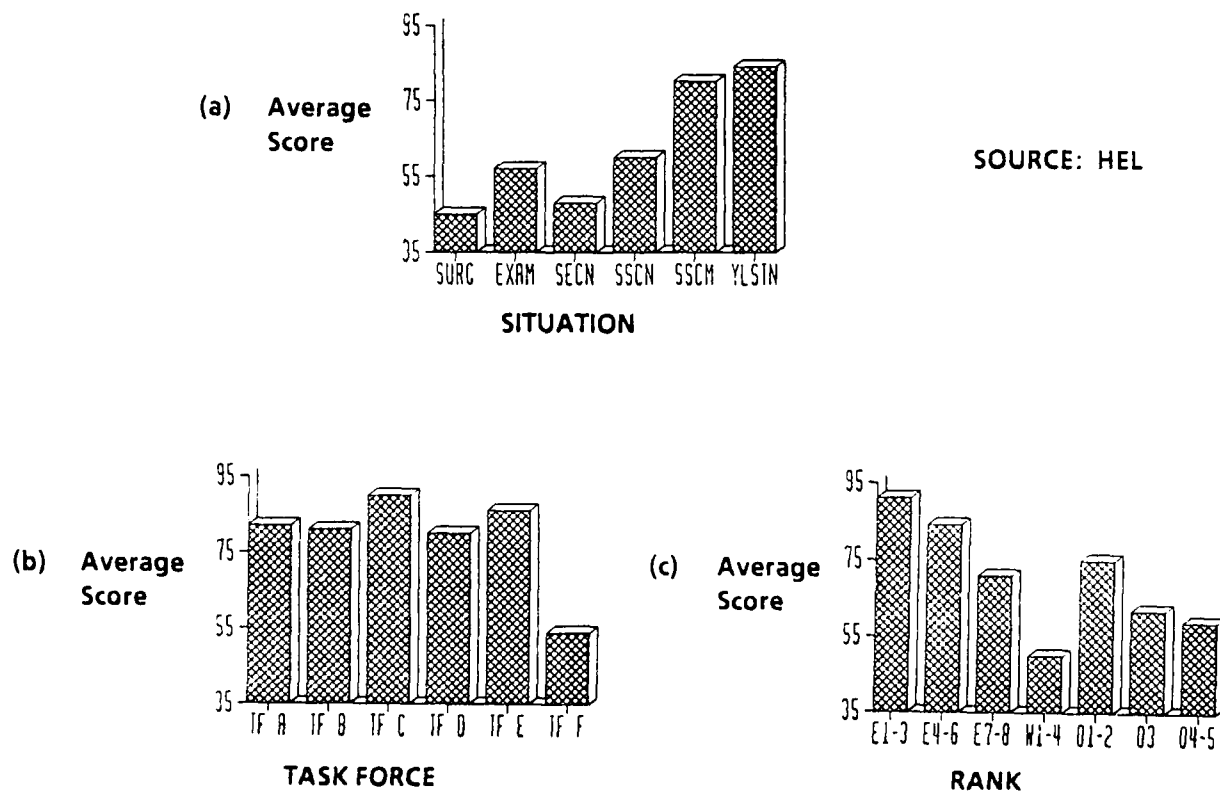


Figure 5-6. MAACL-R Hostility Ratings (possible range is 39 to 237)

g. Soldiers are uncertain. A topic that came up over and over again in interviews and in comments on the questionnaires is uncertainty. First, the soldiers were uncertain about when they would go home. Although many had been given a length of time that they would be gone, it was in all cases much less than the actual time. Many were told several different times, each one just a little longer than previously--10 days, then 14 days, next 21 days, and finally a month. (The only thing they were all sure of was that the Army would get them home before they had been gone 30 days. After 30 days they would have to be paid their separation allowance.) On a daily basis, they were uncertain about the kind of work they would do, where they would do it, how they would get there, and how they would get back to their camp. They were uncertain about their families and worried that they might be gone so long that the mortgage or car payment would not be paid. When they were performing fuel reduction work rather than fighting fires, they were uncertain about why they were still there if there were no fires to fight.

h. Other stress measures. There are charts for other MAACL-R measures and for other soldier 0-100 ratings which allow the reader to compare the Yellowstone experience with the other situations, compare task forces, and compare ranks. In all of these you will find the same patterns. When the measure is negative, task force C has the highest rating, followed by task force A, with task force F having the lowest Yellowstone rating. Similarly, the lowest enlisted have very high ratings, while the highest ranked officers have the lower ratings. When the measure is a positive rating the patterns are exactly reversed. These charts are provided in Appendix I.

i. Soldiers were stressed at Yellowstone. We are certain that soldiers were stressed at Yellowstone, more so than HEL has been able to measure in other situations. We are uncertain at this point as to which stressors were the cause of the most stress. Since the soldiers felt they lost a significant amount of weight, we believe that they were physically stressed. We also believe that they were psychologically stressed, but without determining whether soldiers who gained weight were also depressed and hostile, we can not say whether the psychological stress was a result of the physical stress or was in addition to it (these measures were on different questionnaires). We believe that a well-prepared team on site during a similar operation would be able to sort out some of these issues.

5-6. EEA 5. Is either the sleep loss or stress severe enough to continue to another phase which better measures performance on military tasks? Yes, we believe that stress levels were high and that we should continue to plan for another phase.

a. Sleep Loss. Although we were unable to measure sleep loss, we believe that sleep loss probably occurred in some phases. Soldiers did work at night; it may sometimes have been after working during the day. There are other circumstances in which soldiers do lose sleep which could be studied. WRAIR has the actigraphs which will provide us objective sleep measures.

b. **Other Stressors.** The overall stress levels, even though our measurements were as much as 10 days or more after the stress occurred were still higher than any HEL had measured before. Therefore, we feel that other forest fires would be a productive opportunity for data collection. There are physical stress measures which would provide objective measures to complement the subjective measures. We will determine the feasibility of incorporating these measures.

c. **Other Situations.** There are other situations that we believe would also provide useful information. If we prepare for studying forest fires, we will also be prepared for studying these other situations.

(1) **Baseline Data.** We would understand these data better if we had a large set of baseline data collected from the same group of soldiers when they are not, and have not recently been, stressed.

(2) **Training Data.** Recent Army lore tells us that leaders are more stressed at the National Training Center (NTC) than are the followers. We believe that we should collect similar data at NTC, and perhaps some other training situations, so that we can compare training with a real operation (Yellowstone). We would prefer that these data be from the units we studied at Yellowstone so that direct comparisons can be made. However, any similar units would provide useful data.

(3) **Operational Data.** A fully prepared, multidiscipline, multiagency study team such as this one could accompany the soldiers on other military operations, or immediately behind in an operation such as that in Grenada a few years ago, ready to come in as soon as the area was secured. The amount, range, and usefulness of data that could be collected in these circumstances are beyond compare.

d. **Subjects.** With enough subjects, in enough different circumstances, many questions can be answered. In this study, we had around 1,000 respondents; in laboratory studies, it is difficult to get more than a few. The number of subjects in HEL studies on the comparative charts ranged from 17 to 40.

e. **Subjective versus Objective Data.** In this study we were able to collect only perceptions and soldier feelings (subjective data). In another, prepared phase, there are objective measures, i.e., military task performance or amount of sleep obtained, that could be collected to complement the subjective data. The number of subjects on the objective portions might not be as large as this study, but we could obtain adequate numbers in many different situations. There are many improvements that could be made to the questionnaires which would allow us to make more definitive statements about the subjective data. Figure 5-7 graphically presents the measures collected this time versus those we could collect in another phase. The ovals are data or information that we found at Yellowstone; the irregular clouds are measures that we know we can collect or believe we might collect (the latter are designated by question marks--cohesion and leadership).

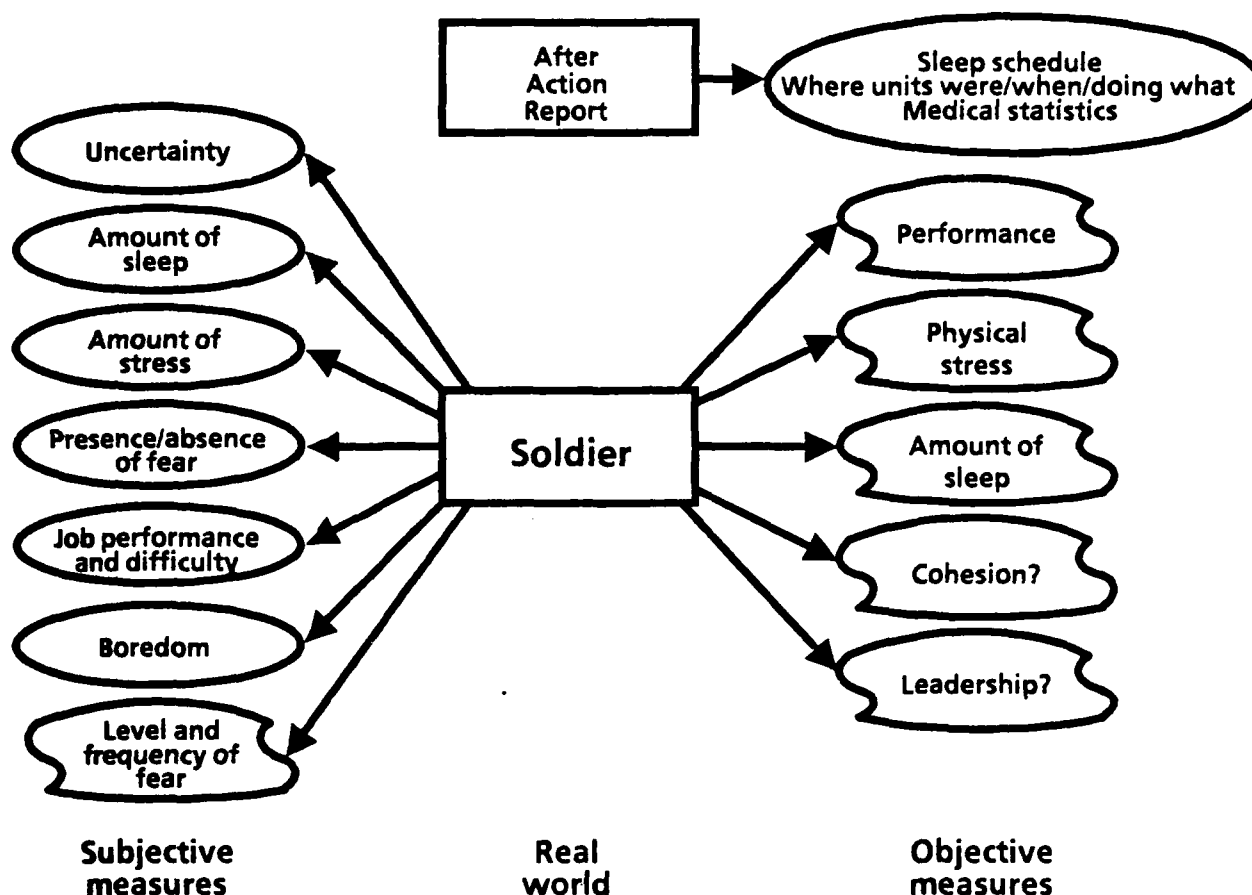


Figure 5-7. Data That Could be Collected

5-7. EEA 6. What lessons learned should be applied to another phase? The most important lessons are: be prepared, be there while it's happening, and be flexible. The team learned about forest fire fighting--how it is organized, what tasks fire fighters do, what their weapons are, who determines schedules, and the buzz words. We also learned what things we would do differently next time, and what worked well for us. These are more fully described in the following paragraphs.

a. **Be Prepared.** This statement subsumes a multitude of things that we will do differently before we study another unit. We knew at the time that most of them could have been done better, but now that we've been there we know which are important and which are not. Only the important are listed here.

- One integrated questionnaire is a must. Administering two questionnaires is confusing for the subjects. In a field environment, lengthy verbal instructions cannot be heard, and long, written instructions cannot be read.
- There are rich data sources that should all be mined. For example, there may have been operational information that would have been useful to other study groups on subjects such as aviation, maintenance, and communications. We would liked to have looked at leadership and unit cohesion.
- It is important to have objective measures as well as subjective measures. Examples of possible objective measures are amount of sleep obtained with the WRAIR actigraphs, performance on MOS tasks, and cognitive test performance (using tests that have been shown to correlate with military performance).
- Simple responses are easier for the soldiers and easier for the analysts. It took an inordinate amount of time to develop codes for the fill-in-the-blank types of the questionnaire items, then to go through the two sets of more than a thousand questionnaires each, coding all of them for data entry. It would have been easier for the soldiers, and easier for us if most of the items had been multiple choice, yes/no, or check list. The conditions are difficult for soldiers to fill out questionnaires. When the questionnaires are difficult, it increases their workload.
- Although optically scanned answer sheets are nice for the analyst, they are impossible in a field environment. We originally wished we had time to develop them. By the time we finished, we were very glad we had not had the time.

b. **Be There.** During the data analysis, report writing and briefing preparation, we repeatedly said, "If only we'd been there in time!" It is difficult to interpret the data when you know that only some soldiers in a task force were surrounded by fire, but you do not know which ones or even how many were in the group; or how many soldiers of the group really had to hike 12 miles in and 12 miles out; and how many days they hiked versus being bussed or flown in. Also, since stress decays with time after the stressing event, we cannot estimate how high the original stress levels may have been.

c. **Be Flexible.** This is a major requirement, but there is little more that can be said about it except, "Remember Murphy's First Law--if it can go wrong, it will."

d. **Simple Volunteer Document.** For each questionnaire, the soldier had to read a volunteer statement; fill in name, rank, social security number, and date; then sign the statement. Not only did we have two separate documents, but the soldiers did not understand the point of the documents; they did not always understand the words used; and they did not understand why they had to sign even one of them. They felt that the fact that they filled it out (since there were some in every group who did not) should have been enough evidence that they were volunteers.

e. **Small Groups.** Some of the most valuable information for interpreting the results come from soldier interviews. When the groups are large, not only is there too much commotion for the soldiers still working, but the analysts are too busy to take time to talk to the soldiers.

f. **Loose Schedule.** There must be enough time in the schedule to allow for exigencies such as the questionnaires and pencils not arriving as planned, to provide time for the analysts to eat and to rest; and to discuss and change procedures when necessary. This team was so rushed (we returned 9 days after we decided to go) that everyone arrived at home exhausted and not ready to begin analyzing data. It still seems a miracle that we managed to recover from the luggage delay without having to cancel at least the first group.

g. **Need Officers on Team.** It's not that officers make better analysts or can stand the rigors of the trip better. It is a field environment, and everyone is very busy. When civilians arrive, the soldiers assume they are reporters or tourists. When the soldiers see officers (we had two, a major and a colonel), someone decides that they should take the time to find out what or who they're looking for.

h. **Don't Stress the Study Team.** This may be the most important item! Because we arrived as the fires were going out, we tended to schedule ourselves too tightly with not enough time for eating and sleeping, and the trip was difficult and tiring. This group was (purely accidentally--most of us had never met) a compatible group of optimists, who tended to see the humor in situations rather than the depressing aspects. We may have returned feeling physically ill, but we all enjoyed the experience anyway and are looking forward to another opportunity. This was the first opportunity we had had to collect data that seemed representative of combat.

5-8. **OBSERVATIONS.** This paragraph describes observations on issues other than those discussed in the responses to the EEA.

a. **Officers versus Enlisted.** Officers at Yellowstone responded very differently to the questionnaires than did the enlisted. If these differences are not a unique result of fighting forest fires, they have implications for training of officers, combat neuropsychiatric cases, and studies of leadership and motivation.

(1) All of the data that we collected show that officer responses were very different from enlisted responses. All of the bar graphs shown previously in this chapter and in Appendix I show that the enlisted soldiers rated the Yellowstone experience as more stressful and as more life-threatening. They felt their coping efficacy was lower. They were more depressed, more hostile, more anxious (page I-3), and had fewer good feelings about themselves (Positive Affect (page I-3)). In general, enlisted soldiers' duties were more physically difficult and more life-threatening than were officers' duties. The differences in feelings may have been a result of the duties they performed, or the fire may have magnified differences that already existed. It seems important that the Army determine whether differences such as these always exist or are a result of different duties. If the latter, then it is important to know whether there is something unique about fighting forest fires, or whether similar reactions

can be expected in most operations, particularly combat. It is possible that knowing the psychological changes that result from combat or combat-like operations could help in developing techniques that will avoid the high rates of neuropsychiatric breakdowns that are expected during intense combat.

(2) There is one more set of data that should be examined here--a measure called sensation seeking that comes from the analysis of the MAACL-R. As you can see in Figure 5-8, there is little difference between any of the task forces which are nearly all enlisted (TF A through E). There is a greater difference between them and TF which has a large number of warrant officers and senior commissioned officers. On the rank chart, there is both a large difference between the lieutenants (O1-2) and the more senior commissioned officers, and between the latter and all enlisted. The warrant officers (W1-4) are approximately the same as the senior commissioned officers. Since there seems to be little difference among the first five task forces, this measure seems relatively unaffected by the fire fighting. If these differences exist in all situations, there may be motivation implications that are important for officers to better understand. Since sensation seeking tends to be associated with higher pay and education levels, we believe these differences are not related to the Yellowstone experience.

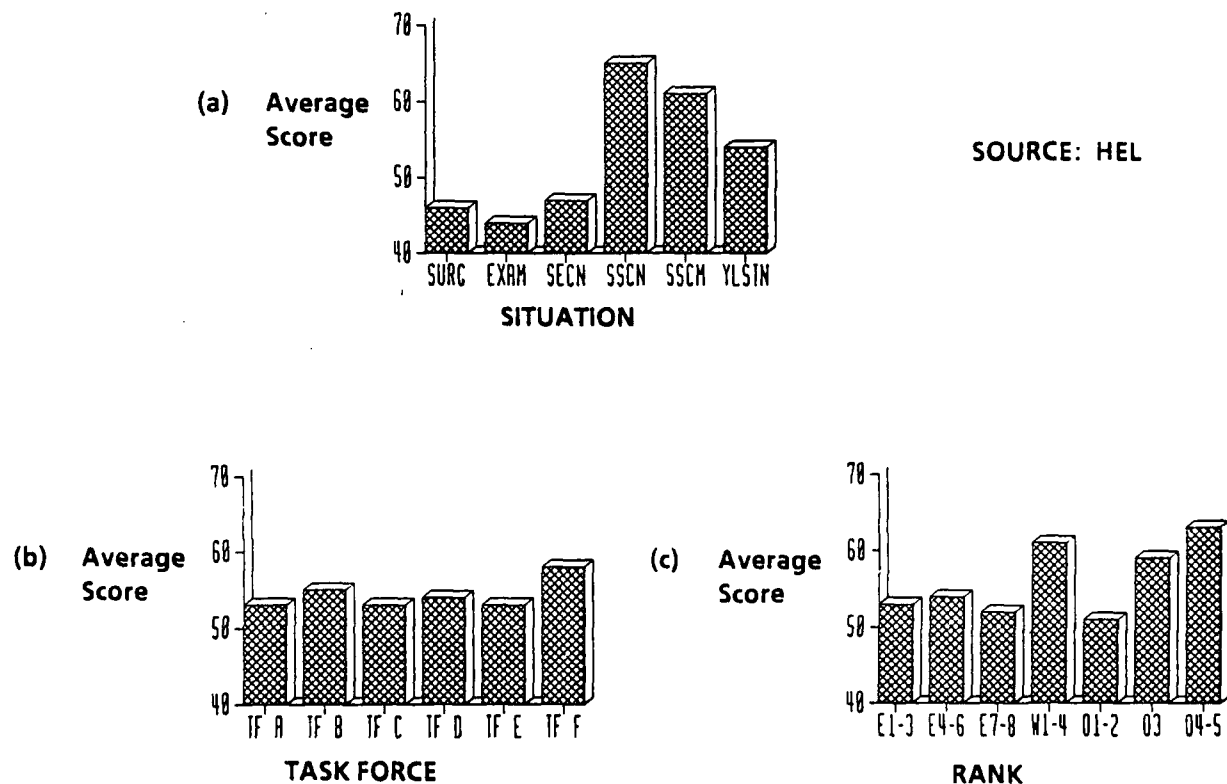


Figure 5-8. Sensation Seeking, from the MAACL-R (possible range is 28 to 82)

b. Issues for Future Studies

(1) **Leadership.** An earlier table (Table 5-7) showed that significantly more higher ranked enlisted soldiers (E-5 through E-8) felt that their activities were well-organized by their supervisors than did the lower ranks (E-1 through E-4). The officer ratings on the same question were significantly higher than any of the enlisted. On the questionnaires, we found comments that thought the military was much better organized than the Forest Service and more able to make decisions, but we also found that some soldiers claimed the military supervisors were the unorganized, indecisive ones. This is an issue that we will look at more closely in the future.

(2) **Medical, Maintenance, and Logistics.** Now that we have completed our analyses of soldier stresses at Yellowstone, we are studying the after action report to determine whether there were any unique medical, maintenance, or logistics issues that might have relevance to combat. If so, we will include them in our future planning.

5-9. FUTURE STUDIES. In previous paragraphs we referred to better methods for future studies. In paragraph 5-6, we said that we felt that continuing to another phase would be fruitful, and in paragraph 5-7, we discussed lessons learned that could be applied to another phase. In paragraph 5-8, we presented additional issues that should be studied. Present plans are that we will continue to several other phases. The first one will be the preparation phase--it must be completed before the time that the next forest fires could require the involvement of the Active Army, i.e., by August 1989. The other phases will be studying the Army in various operations. These are briefly described below.

a. Tool Kit Development. During this phase, a Stress Measurement and Assessment Reaction Team (SMART) will be created, and memorandums of understanding among the various agencies will be signed. The tool kit of measurement instruments will be developed. This will include both subjective and objective measures. Other issues such as those described above (paragraph 5-8b) will be examined for inclusion in the study, and any other required instruments will be developed. The number of respondents needed for each issue and measurement tool will be determined, and a designated team will be ready as a rapid reaction team. Prior to deployment of the first troops for fighting forest fires, questionnaires will be designed, printed, and packed for shipping; analysis procedures will be developed and tested; a contract for keying the data will be in place; use of human subject protocols will have been developed and approvals will have been obtained; actigraphs will have been designated for this use; and team member or NCO training (for testing performance on military tasks) will have been completed.

b. Exercise Data Collection and Analysis. The results of this study showed that the enlisted soldiers were much more stressed than the officers. Anecdotal evidence tells us that officers are more stressed at the National Training Center. We believe that the Army should know who and in what ways training is stressing both the officers and the enlisted soldiers. We propose to study both NTC and other training exercises. It may be that NTC

stresses the officers while other training stresses the enlisted. In order to properly evaluate operations such as fire fighting, we need to know what the differences are between those experiences and training experiences. We hope to study and compare training results with results from the soldiers from Yellowstone. We hope to arrange to study the same soldiers--the 9th ID.

c. **Other Army Operations Data Collection and Analysis.** The first operation that we plan to study, if there is a large forest fire for which the Army is called in 1989, will be the fire. We will be there before the soldiers arrive (we will be prepared and trained; they will not be expecting the forest fire fighting mission and will need training in fighting forest fires) to study the entire process. We will find out how tired they are when they arrive, see how active their schedules are, find out how much they sleep, and determine whether they are actually stressed from fighting the fires or from other events happening at the same time. After that, or if there is no suitable fire in 1989, we will be ready to go with (or after if there is real combat) the soldiers to collect important information on the process, the results of the process on the soldiers, and effects of the soldiers on the process.

d. **Baseline Data Collection and Analysis.** The tool kit developed by SMART should be used to develop statistics on the soldiers when they have not been unusually stressed. Although arrangements have not yet been made, we will, if possible, develop these measures on the 1st Brigade of the 9th ID to compare with the measures from Yellowstone. If we study other units in other operations, we will study them in garrison, after they have had time to return to normal. If we study different units at NTC or other training sites, we will plan to collect the baseline measures prior to the training.

5-11. **SUMMARY OF RESULTS CHAPTER.** We described the results of the FIRE Study in this chapter by answering each of the essential elements of analysis. A very brief summary of the data analyses is that stress levels were very high; since the stress is highly correlated with the amount of fire fighting, we believe fear may be a causative factor; many soldiers were physically stressed; and enlisted soldiers seem to be very different from officers. We believe that these results show that valuable data can be collected from Army operations and training exercises, and we presented the most important lessons learned. Finally, we described future efforts such as the tool kit development and studies of training exercises and operations, as well as baseline measure collection.

CHAPTER 6

SUMMARY

6-1. INTRODUCTION. The purpose of this chapter is to briefly summarize the study report findings. Since this study is the first of several that are now planned, future plans are briefly addressed.

6-2. FINDINGS

a. We identified a variety of stressors at Yellowstone. They range from traditional combat stressors (such as fatigue, terrain, and fear), to stressors that should be added to the list of traditional stresses (examples are austere living conditions and hostile environment) to Yellowstone-unique stressors (working with civilians).

b. The danger caused by fire and other threats to personal safety in forest fire fighting causes very high stress levels--significantly higher than the Army has previously measured in controlled settings. In this aspect, forest fire fighting is similar to combat.

c. The danger of forest fire fighting is usually less than combat danger. Both the Forest Service and the Department of Defense feel that personal safety is more important than trees and grass. This latter aspect is different from combat, i.e., although personal safety is important in the combat situation, it may not always take precedence over controlling or extinguishing the enemy.

d. Because the Forest Service schedules adequate sleep periods, the sleep loss suffered in forest fire fighting is usually less than is expected during periods of intense combat. Soldiers are remarkably consistent in estimating that they can continue physical work for 32 hours without sleep, or 7 days with adequate sleep.

e. The physical stress of forest fire fighting may be greater than the physical stress of combat. Although most of the soldiers probably had no combat experience, the physical stress does seem to be greater than that for which the soldiers train. Nearly all soldiers (80 to 97 percent, depending upon the task force) feel that fire fighting is physically harder than their MOS. Two-thirds thought they had lost significant amounts of weight. They told us that physical training and tests were not adequate preparation for the rigors of forest fire fighting. This data provides nothing that allows us to determine whether training standards may be too low, or whether combat may usually be less physically stressful than forest fire fighting.

f. Every aspect of the forest fire fight seemed to stress soldiers--from the deployment process itself, to the boredom experienced when they were performing fuel reduction duties, or waiting to find out where and what they would do today. Whether from stress or physical exertion, one-third felt that someone in their crew became so tired that they were a danger to themselves or to others on the crew.

g. Officer responses were very different from enlisted responses. The enlisted soldiers rated the Yellowstone experience as more stressful and as more life-threatening. They felt their coping efficacy was lower. They were more depressed, more hostile, more anxious, and had fewer good feelings about themselves. Their duties were more physically difficult and probably more life-threatening. It is important to know whether there is something unique about fighting forest fires, or whether these differences should be expected in most operations, particularly combat. It is possible that knowing the psychological changes that result from combat or combat-like operations could help in developing techniques that will avoid the high rates of neuro-psychiatric breakdowns expected during intense combat.

6-3. FUTURE PLANS. We plan several other phases. The first one will be the preparation phase--it must be completed before the time that the next forest fires could require the involvement of the Active Army, i.e., by August 1989. The other phases will study Army soldiers during various operations--garrison for base case data development, training such as at NTC, other forest fires if they develop, or, if there is no suitable fire in 1989, we will be ready to go with (or after, if there is real combat) the soldiers in any actual operation to collect important information on the process, the results of the process on the soldiers, and effects of the soldiers on the operation process.

APPENDIX A
STUDY CONTRIBUTORS

1. STUDY TEAM

a. Study Director

Ms. Sally J. Van Nostrand, Force Systems Directorate

b. Team Members

Ms. Patti L. Rennekamp, US Army Concepts Analysis Agency
MAJ James King, US Army Laboratory Command
Ms. Linda T. Fatkin, US Army Laboratory Command
Dr. Donald B. Headley, US Army Research Institute
COL Daniel Redmond, Walter Reed Army Institute of Research
Dr. Gerald A. Hudgens, US Army Laboratory Command
(did not go to Yellowstone)
CPT John Lew, Walter Reed Army Institute of Research
(did not go to Yellowstone)

2. PRODUCT REVIEW BOARD

Mr. Franklin McKie, Chairman
LTC Jerry Edelen
Dr. Elizabeth Abbe
Mr. Brad Knowlton

3. EXTERNAL CONTRIBUTORS

BG Taylor, Commander, Joint Task Force, Yellowstone
COL Van Alstyne, Commander, 1st Brigade, 9 ID
LTC Brittan, Commander, 4-23 IN
LTC Cochran, Commander, 1-11 FA
LTC Mackey, Commander, 2-2 IN
LTC Schatthauer, Commander, 2-0 AV
MAJ Robershotte, Commander, 1-52 ADA
CPT Gallup, Judge Advocate and study team Yellowstone escort

APPENDIX B

STUDY DIRECTIVE



REPLY TO
ATTENTION OF:

DEPARTMENT OF THE ARMY

US ARMY CONCEPTS ANALYSIS AGENCY
8120 WOODMONT AVENUE
BETHESDA, MARYLAND 20814-2797

CSCA-FSP (5-5d)

28 MAR 1989

MEMORANDUM FOR Assistant Director, Force Systems

SUBJECT: FIRE Study Directive

1. **PURPOSE OF STUDY DIRECTIVE:** This is the study directive for the Fire Fighting Task Force Study (FIRE). The fire fighting task force studied forest fire fighting soldiers during September, 1988.

2. **BACKGROUND:** There is a recent CAA effort to develop the techniques and data that are necessary to fully represent combat in the agency combat models by including the necessary soldier characteristics. Although there is much laboratory research data on human performance, there is very little human performance data which has been collected in near-combat conditions such as field training exercises (FTX). There is less data from actual combat conditions, and there seems to be no way to collect new combat data. In some ways, however, forest fire fighting seems to be similar to combat--there are life-endangering situations and fighting forest fires is a continuous operation. Therefore, performance data collected from soldiers while they are fighting fires could fill an important gap in present data. In September, 1988 the Director, CAA, with the approval of ODCSOPS approved the hasty organization of a study of the Army forest fire fighters at Yellowstone Park to determine whether forest fire fighting has combat similarities and to collect as much data as possible in the limited time available. This directive documents the beginning of that effort and provides for the completion of the FIRE Study.

3. **STUDY SPONSOR:** The study sponsor is the Director, CAA.

4. **STUDY AGENCY:** Force Systems Directorate of CAA developed and managed the task force. It will integrate research results from other Army agencies and write the FIRE final study report. Since this is a unique opportunity for research that is seldom otherwise available, other Army agencies were invited to participate in the task force. All who were invited took the opportunity. They are: the Army Research Institute (ARI) Systems Research Laboratory (SRL); the Human Engineering Laboratory (HEL) Behavioral Research Directorate; and the Walter Reed Army Institute of Research (WRAIR) Department of Behavioral Biology.

5. **TERMS OF REFERENCE:**

a. **Scope.** The FIRE Study is limited to the Army soldiers who fought the forest fires in and around Yellowstone Park. Civilian fire fighters are very different in age, physical training, discipline, and other factors such as leadership, unit cohesion and morale. Army fire fighters in garrison probably do not have the same potential for continuous danger and for needing to work to the exhaustion point.

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b. Objectives.

(1) The major objective is to collect and analyze data on the fatigue and stress of forest fire fighting. From this data we should be able to determine what the major factors are that cause fatigue or stress when fighting forest fires and decide whether the effects of forest fire fighting are actually similar to effects of combat. If the effects of forest fire fighting are similar to those of combat, we can then develop estimates of the soldiers' performance during combat. These estimates can be used as data in the combat models.

(2) A secondary objective is to build an information base which can be used to design a more complete field study which measures the factors that cause forest fire fighting stress and the differences in soldier performance which are caused by those stresses.

c. Timeframe. Since humans require eons to develop real differences from previous generations, rather than the months or years used for equipment and organization changes, these data should apply to all soldiers in the foreseeable future, or, at least, until the medical community actually develops a "chemical man."

d. Essential Elements of Analysis (EEA).

(1) What are the major factors that cause stress while fighting forest fires? Other related questions that should be answered here are: Was fear one of the stresses? Are the factors the same as the factors that cause stress during an FTX?

(2) Does forest fire fighting cause combat-like stress? Other questions that should be answered with this EEA are: If the stress is not clearly like that caused by combat, what other measures are needed for clarification? How does the amount of stress compare with that generated for laboratory or field experiments? Does the amount of stress vary by unit? If so, can the reason be identified?

(3) How does sleep loss affect soldier performance? Examples of other questions involved in this are: How much do soldiers and commanders believe they sleep while fighting forest fires? Do they believe that their performance is affected by the sleep loss? Is the sleep loss severe? Does sleep loss vary by unit? If so, can the reason be identified? Can the sleep loss be equated to that envisioned for continuous operations during a war?

(4) How do other stresses affect soldier performance? Examples of other questions involved in this are: Do the soldiers or commanders believe that forest fire fighting stress affects their performance? Is the stress caused by forest fire fighting different for soldiers than for the commanders? Is it different by unit? If so, why?

(5) Is either the sleep loss or stress severe enough to continue to another phase which better measures performance on military tasks?

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(6) What lessons learned should be applied to another phase?

e. Tasks.

(1) Organize task force and develop or acquire test instruments (this task was completed prior to development of this study directive). CAA organized the task force, provided coordination with ODCSOPS and the Yellowstone Joint Task Force, and made travel and lodging arrangements. ARI, HEL and WRAIR provided human research expertise and data collection instruments. Objective measurements are most desirable. However, subjective questionnaires are necessary for most of this data collection. Since the FIRE task force had less than 48 hours in which to develop questionnaires and there were 4 agencies involved, it was impossible to develop one integrated questionnaire. Instead, HEL developed one questionnaire which specifically measured stress levels (their particular interest), and ARI developed another questionnaire which addressed their interest in continuous operations and included items which were of interest to the medical community (such as weight loss, food and water availability).

(2) Collect data (Completed). Stress and fatigue data should be collected immediately after the stress event. Since some of the units had redeployed to Fort Lewis prior to task force formation, data from these units will necessarily show some decay of stress and fatigue levels.

(3) Analyze data. Since there are two questionnaires, each agency which developed one is responsible for the data reduction and analysis of their questionnaire. HEL and ARI are providing their results to each of the other agencies. CAA will obtain and study the After Action Report to glean all possible information from it. CAA is responsible for integrating the results to provide answers to the FIRE Study EEAs.

(4) Write final report. CAA will write and publish the FIRE final report. The report will, with appropriate attribution, use graphics and data provided by ARI and HEL. It will include appendices, also with attribution, which are executive summaries from research reports published by the other agencies.

6. LITERATURE SEARCH: Hundreds of documents are in the Defense Technical Information Center files which show soldier performance in laboratory conditions, and there are a few which evaluated the decision process of allocating resources among fires. However, the only documents on studies of soldier performance during actual Army operations are from the Korean war timeframe. No field study of soldiers during forest fire fighting has previously been attempted. The FIRE Study is unique in that it (a) uses the specialized research capabilities of several different organizations; (b) has an overall focus of developing data on soldier capabilities that is useful in combat models; and (c) studies real Army operations rather than laboratory or field simulations.

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7. RESPONSIBILITIES:

a. Force Systems Directorate, CAA will provide the study director to coordinate the effort, prepare briefings, and write the final study reports.

b. Each agency involved will furnish TDY funds as needed for their personnel, provide analysis capabilities for the data that is collected for their unique purposes, provide report production facilities as needed for reports published under their cover, and provide each of the other agencies with analysis results as they become available.

(1) ARI is responsible for the analysis of the ARI-developed continuous operations questionnaire.

(2) HEL is responsible for the analysis of the HEL-developed stress questionnaire.

(3) CAA is responsible for the analysis of the After Action Report.

8. REFERENCES:

a. AR 5-5, Army Studies and Analysis.

b. Study Directors' Guide, CAA, May 1986.

9. ADMINISTRATION:

a. Products. The CAA final products for the FIRE study will be an ARB presentation and a written study report. Other agencies will publish their own research reports as desired.

b. Milestones.

Study Start	21 September 1988
Task force organized and test instruments designed or acquired	23 September 1988
Data collection completed	30 September 1988
Data analyses completed	10 February 1989
Initial/final FIRE ARB	17 February 1989
Study report published	15 April 1989

c. Force Systems Directorate will prepare and submit Form 1498 and final study documents to DTIC.


E. B. VANDIVER III
Director

APPENDIX C
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APPENDIX D
ARI QUESTIONNAIRE

This appendix is the questionnaire for the Fire Fighting Task Force Study which ARI created. It addresses continuous operations and medical issues. It asks questions about the deployment process, training, rest or sleep periods, previous experience with continuous operations, and whether the soldier experienced threats to personal safety. The ARI report on this research is at Appendix E.

DATA REQUIRED BY THE PRIVACY ACT OF 1974 (5 U.S.C. 552a)	
TITLE OF FORM Questionnaire for Fire Fighters	PRESCRIBING DIRECTIVE AR 70-1
1. AUTHORITY 10 USC Sec 4503	
2. PRINCIPAL PURPOSE(S) The data collected with this questionnaire are to be used for research purposes only.	
3. ROUTINE USES This questionnaire was developed by the U.S. Army Research Institute for the Behavioral and Social Sciences pursuant to its research mission as prescribed in AR 70-1. When identifiers (name or Social Security Number) are requested they are to be used for administrative and statistical control purposes only. Full confidentiality of the responses will be maintained in the processing of these data.	
4. MANDATORY OR VOLUNTARY DISCLOSURE AND EFFECT ON INDIVIDUAL NOT PROVIDING INFORMATION Providing information on this questionnaire is voluntary. Individuals are encouraged to provide complete and accurate responding in the interests of the research, but there will be no penalty for not providing all or any part of the responses.	
FORM	Privacy Act Statement - 26 Sep 75

DA Form 4368-R, 1 May 75

VOLUNTEER CONSENT FORM

I have read the description of the research, including the information on the questionnaire provided, and I understand the inconvenience involved by my participation. I understand that my participation in the research is voluntary on my part, and that I may withdraw from the research at any time without prejudice. I have read the Privacy Act statement (DA Form 4368-R). I have been given an opportunity to ask questions concerning this research, and any such questions have been answered to my full and complete satisfaction.

Signature of Volunteer and Date

QUESTIONNAIRE FOR FIRE FIGHTERS

Your Social Security Number _____ Your Unit ID: Btn _____ Co _____
Pltn _____

Your duty MOS _____ Your Duty Position Title _____

Length of time in this MOS _____ Rank _____

Previous experience in long workdays:

Did you work on the fire line in last year's fire? _____

Have you participated in 24 hour or longer mission assignments either in combat or training exercises in which you only got a few hours sleep each night? (Yes/No) _____. If yes, what was the number of days of your longest continuous mission _____

How many hours do you feel you can remain awake and still maintain operational effectiveness for physical type duties? _____

Preparation and Training for your Fire Fighting Duties:

- o How did you get from Fort Lewis to Yellowstone?

_____ Air _____ Ground

How long did it take? _____

- o How many days was your training session at the Yellowstone Base Camp area? _____

- o What percentage of the training session involved physical work on your part _____

- o What percentage of the training session involved instruction on fire fighting techniques? _____

- o How tired were you after the training period?

_____ very tired _____ somewhat tired _____ rested

- o How did you get from Yellowstone to the fire site?

_____ Air _____ Ground Vehicle _____ By foot

How long did it take? _____

- o How tired were you when you actually began your fire fighting duties? _____ very tired _____ somewhat tired _____ rested

FIRE LINE ACTIVITIES

Page 2

What kinds of duties did you have in the fire area on a typical shift
(Examples, cutting firebreaks; starting controlled backfires):

What kinds of equipment did you use in the fire area on a typical shift:

____ shovel ____ chain saw ____ walkie talkie

Others (please list): _____

Fighting fires is physically (harder / not as hard) as my usual MOS tasks are during a field training exercise (FTX).

Fighting fires is mentally (harder / not as hard) as my usual MOS tasks are during a field training exercise (FTX)..

Do you feel that your ability to do work decreased as the number of days on this job increased? (Yes/No) _____

o If yes, check those which apply from the list below:

- _____ Lack of sleep affected my physical stamina
- _____ Lack of sleep affected my ability to think clearly
- _____ The type of work I did wore me out
- _____ I didn't get enough food
- _____ I didn't get enough water
- _____ There weren't enough rest periods

o 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?
_____ Hours _____ Days

o After how many hours or days in the fire area did you first start to get tired to the point that you were not able to think clearly?
_____ Hours _____ Days

o After how many hours or days on the fire line did you feel your worst?
_____ Hours _____ Days

Did you or any of your crew members become so tired that you became a danger to yourselves? (Yes/No) _____

Were the activities of your group well organized by your supervisor?
(Yes/No) _____

FIRE AREA ACTIVITIES, cont.

Page 3

While you were on the fire line,

- o Did you ever feel your personal safety was threatened by the fire?
(Yes/No) _____
- o Were there ever times when you or your crew were out of touch or
isolated from other units? (yes/No) _____

How much weight, if any, do you think you lost during your fire
fighting duty? _____Were you told how many days you would be involved in the fire
fighting duties (Yes/No)? _____

If yes, how many days were you told? _____

How many days did you actually spend in the fire area _____

On a typical day in the fire area:

- o How many hours did you work? _____
- o For your rest periods
 - Did you know how long your rest breaks would last? _____
 - How many times a day did you sleep for the following
durations:
 - _____ less than 1 hour _____ 1-2 hours _____ 2-3 hours
 - _____ 3 or more hours
 - What were your usual sleeping conditions when you were able
to take an actual sleep break?
 - _____ Sleeping bag _____ Motel room _____ Other (specify)

Did you work on a specific shift schedule? _____

If yes, what hours were you on the fire line _____ to _____

Were you told in advance how many days you would be in the fire area
before you would have time off? (Yes/No) _____ If yes,

What were you told:

What was your actual schedule

_____ days on the fire line,
_____ followed by
_____ days off duty,
_____ followed by
_____ days on the fire line, etc.

_____ days on the fire line,
_____ followed by
_____ days off duty,
_____ followed by
_____ days on the fire line

APPENDIX E
ARI RESEARCH REPORT

This appendix presents the report furnished by the US Army Research Institute for the Behavioral and Social Sciences, Alexandria, Virginia. The author is Dr. Donald Headley, Manned Systems Group, Systems Research Laboratory. The subject of the report is the data collected from soldiers who fought fires in and around Yellowstone National Park during August and September 1988. The data was collected using the ARI questionnaire, Appendix D.

FIRE FIGHTING AS EXTENDED OPERATIONS:
THE YELLOWSTONE EXPERIENCE

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Manned Systems Group
Systems Research Laboratory

U.S. Army
Research Institute for the Behavioral and Social Sciences

March 1989

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) and 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 which 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 US 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 needed performance data for combat models.

Forest fire fighting would, indeed, seem to offer some data on fatigue and 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" (US 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 travelled to the Yellowstone area in late September to administer questionnaires to the soldiers who were still on site, then went to Fort Lewis to gather data from those soldiers who had returned home. 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 attitudes towards the experience and soldiers' 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, in 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. 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 per cent 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 which 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).

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.

Responses were coded, entered into a computer, and analyzed by the SAS

TABLE 1

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

GTF	Rank					Totals
	E1-E4	E5-E8	O1-O5	WO1-WO3	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).

statistical 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 days. 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 0500, 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. Around 1700 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 B, 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. 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" 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

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	
^a Cutting Fire Breaks	35	35	32	32	22	33
^b Mop Up	26	25	24	24	30	24
Back Fires	4	8	16	16	4	8
^c Cutting Snags & Branches	12	7	5	6	6	7
Hose rolling, Unrolling	13	5	9	9	6	8
^d Fuel Reduction	3	3	6	2	21	6
Others	7	17	8	11	11	13
Number of Activities Cited	352	591	330	198	654	^e 2301

^a

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.

^b

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.

^c

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

^d

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.

^e

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

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 (Table 4).

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 5). 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 6); the estimates over 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 7).

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 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 8). 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' placement in a section labeled "Preparation and Training for 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

TABLE 3

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

Equipment	Ground Task Force					All
	C	E	A	D	B	
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 ^a

^a

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

Comments by Soliders Concerning Conditioning and Forest Fire Fighting

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

TABLE 5

Previous Experience in Extended Operations, Enlisted Soldiers

Item	Ground Task Force					All
	C	E	A	D	B	
Military Experience in Long Workdays?						
^a						
% Yes	86	91	92	93	83	88 ^b
Total N of Records	140	217	117	73	194	816
^c						
Longest Continuous Mission, Days						
Average (rounded)	11	13	13	11	13	12
Standard Deviation	14	19	16	13	17	17
^d						
Median	3.8	3	5	4	5	4 ^b
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 6

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

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

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 7

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 7, 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.

TABLE 8

Fatigue Status at Start of Fire Duties, Enlisted Soldiers

Category ^a	Ground Task Force					All
	C	E	A	D	B	
% 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 ^b

^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.

(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 7).

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 9); 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 9). 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 7), 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 7).

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 10). GTF 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 10 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 11; "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 7).

Responses to this 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 (84 per cent) versus 70 per cent of those who said "No" (Table 7).

Respondents estimated a decrease in performance after a median stay of 5 days (average = 7) on the job (Table 12). 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

TABLE 9

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

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

a

Test of response pattern differences among the Task Forces was significant (chi square = 49.8, 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.

c

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

TABLE 10

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 ^b
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
^c 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 11

Estimated Weight Change, Enlisted Soldiers

Measure	Ground Task Force					All
	C	E	A	D	B	
Change (pounds) ^a						
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 ^b
% 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

^a

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

^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.

TABLE 12

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

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

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

^a

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

^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.

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 7).

Danger

Respondents were asked "Did you ever feel your personal safety was threatened by the fire?" Fifty-five per cent stated "Yes" (Table 13). 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 14), versus 32 per cent for the officers. The 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

TABLE 13

Perception of Danger by Fire, Enlisted Soldiers

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

^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 14

Enlisted Soldiers' Perception of Organization of Activities by Supervisors

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

Note: Officers' % No = 32.

^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.

comments of substance are presented in Table 15.

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 16. 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 17. 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.

DISCUSSION

The Yellowstone mission represented a noncombat deployment, but in the sense of its no-notice nature was somewhat representative of mobilization for combat. Performance and stamina for physical work in this unique environment

TABLE 15

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

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 15, cont.

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

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 Usage 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."

TABLE 16

The Influence of Enlisted Rank on Responses

Questionnaire Item	Measure	Rank		Statistical
		E1-E4	E5-E8	Test Results
Completeness in Re- sponding				
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	$t = 1.3$, $df = 828$, $p < .2$
Estimations				
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, $df = 1$, $p < .25$
Judgments				
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 16, 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 Or- ganized by Super- visor?	% No	56	43	Chi square = 10.0, df = 1, p < .005

TABLE 17

The Influence of Location of Questionnaire Administration on Responses

Questionnaire Item	Measure	Location		Statistical Test Results
		Yellowstone Area	Fort Lewis	
Completeness in Responding				
No. of Fire Line Activities Cited	Average	3.2	2.5	$t = 6.4, df = 828, p < .001$
No. of Pieces of Equipment Cited	Average	3.4	2.9	$t = 5.3, df = 828, p < .001$
Estimations				
Perceived Stamina	Hours (median)	24	24	Chi square < 1, df=1
Weight Change	Pounds lost (average)	7	5	$t = 4.9, df = 763, p < .001$
When did Your Ability to do Physical Work Decrease?	Days (median)	5	6	Chi square = 2.0, df = 1, $p < .25$
Judgments				
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 17, 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 Or- ganized by Super- visor?	% No	57	50	Chi square = 3.0, df = 1, p < .10

for soldiers was indirectly assessed via responses to a questionnaire. 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.

The fatiguing aspects of the mission were one focus of the questionnaire. The Forest Service, concerned about extended fireline duty and performance, 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).

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. Firefighting does seem to offer some data on extended activities which could pertain to combat. As things turned out, the end point of the mission was unknown for some time (as in war and unlike FTXs), many rated the experience as dangerous, and most of the respondents stated their duties were physically more taxing than those in FTXs (an explanation for this latter fact may be that physical training and conditioning for combat is not necessarily equivalent preparation for fire fighting; i.e., different muscle groups are required for fire line work and its sustained nature).

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.

A factor which probably impacted negatively on performance involved the perceived importance of duties. 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.

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. Finally, obtaining such information as rank is important because many response patterns differed as a function of rank category.

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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.

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.

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

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APPENDIX F
HEL QUESTIONNAIRE

This appendix is the questionnaire for the Fire Fighting Task Force Study which HEL created. It measures stress using two types of measurements. One is the rating, on a scale from 0 to 100 which the soldier provides. It also asks what factors are similar to combat and has other questions about the forest fire fighting experience. The HEL report on this research is at Appendix G.

VOLUNTEER AGREEMENT AFFIDAVIT

For use of this form, see AR 70-25; the proponent agency is OTSG

PRIVACY ACT OF 1974

Authority: 10 USC 2013, 44 USC 3101, and 10 USC 1071-1087.

Principle Purpose: To document voluntary participation in the Clinical Investigation and Research Program. SSN and home address will be used for identification and locating purposes.

Routine Uses: The SSN and home address will be used for identification and locating purposes. Information derived from the study will be used to document the study, implementation of medical programs; adjudication of claims; and for the mandatory reporting of medical conditions as required by law. Information may be furnished to Federal, State and local agencies.

Disclosure: The furnishing of your SSN and home address is mandatory and necessary to provide identification and to contact you if future information indicates that your health may be adversely affected. Failure to provide the information may preclude your voluntary participation in this investigational study.

PART A(1) - VOLUNTEER AFFIDAVIT**Volunteer Subjects in Approved Department of the Army Research Studies**

Volunteers under the provisions of AR 40-38 and AR 70-25 are authorized all necessary medical care for injury or disease which is the proximate result of their participation in such studies.

I, _____, SSN _____, having full capacity to consent and having attained my _____ birthday, do hereby voluntarily consent as legal representative for _____ to participate in _____

HEL Stress Evaluation

(Research Study)

under the direction of Maj James M. King, AV 298-5982
conducted at Yellowstone National Park and Ft Lewis, WA

(Name of Institution)

The implications of my voluntary participation/consent as legal representative; duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by

Maj James M. King, HEL, SLCHE-BR, APG, MD 21005-5001

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights/the rights of the person I represent on study-related inquiry, I may contact

Name at hospital on site will be provided

at _____

(Name, Address and Phone Number of Hospital (Include Area Code))

I understand that I may at any time during the course of this study revoke my consent and withdraw/leave the person I represent withdrawn from the study without further penalty or loss of benefits; however, if the person I represent may be required (military volunteer) or requested (civilian volunteer) to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my/the person I represent's health and well-being. My/the person I represent's refusal to participate will involve no penalty or loss of benefits to which I am/the person I represent is otherwise entitled.

PART A (2) - ASSENT VOLUNTEER AFFIDAVIT (MINOR CHILD)

I, _____, SSN _____, having full capacity to consent and having attained my _____ birthday, do hereby volunteer for _____ to participate in _____

(Research Study)

under the direction of _____

conducted at _____

(Name of Institution)

(Continue on Reverse)

DA FORM 5303-R, MAY 88

PREVIOUS EDITIONS ARE OBSOLETE

PART A(2) - ASSENT VOLUNTEER AFFIDAVIT (MINOR CHILD) (Cont'd.)

The implications of my voluntary participation; the nature, duration and purpose of the research study; the methods and means by which it is to be conducted; and the inconveniences and hazards that may reasonably be expected have been explained to me by _____

I have been given an opportunity to ask questions concerning this investigational study. Any such questions were answered to my full and complete satisfaction. Should any further questions arise concerning my rights I may contact _____

at _____

(Name, Address, and Phone Number of Hospital (Indicate Area Code))

I understand that I may at any time during the course of this study revoke my assent and withdraw from the study without further penalty or loss of benefits; however, I may be requested to undergo certain examination if, in the opinion of the attending physician, such examinations are necessary for my health and well-being. My refusal to participate will involve no penalty or loss of benefits to which I am otherwise entitled.

PART B - TO BE COMPLETED BY INVESTIGATOR

INSTRUCTIONS FOR ELEMENTS OF INFORMED CONSENT: (Provide a detailed explanation in accordance with Appendix E, AR 40-36 or AR 70-25.)

1. The purpose of this study is to evaluate stress level related to your mission at Yellowstone National Park.
2. I understand that I will be asked to complete surveys.
3. There is no risk associated with completing these surveys.
4. All responses and your identity will be kept confidential.

I do ☐ do not ☐ (check one & initial) consent to the inclusion of this form in my outpatient medical treatment record.

SIGNATURE OF VOLUNTEER	DATE	SIGNATURE OF LEGAL GUARDIAN (if volunteer is a minor)	
PERMANENT ADDRESS OF VOLUNTEER	TYPED NAME OF WITNESS		
	SIGNATURE OF WITNESS		DATE

REVERSE OF DA FORM 5303-R, MAY 88

MARK ALL THE BOXES THAT DESCRIBE HOW YOU FEEL RIGHT NOW.

- | | | |
|--|--|--|
| 1 ☐ active | 45 ☐ fit | 89 ☐ peaceful |
| 2 ☐ adventurous | 46 ☐ forlorn | 90 ☐ pleased |
| 3 ☐ affectionate | 47 ☐ frank | 91 ☐ pleasant |
| 4 ☐ afraid | 48 ☐ free | 92 ☐ polite |
| 5 ☐ agitated | 49 ☐ friendly | 93 ☐ powerful |
| 6 ☐ agreeable | 50 ☐ frightened | 94 ☐ quiet |
| 7 ☐ aggressive | 51 ☐ furious | 95 ☐ reckless |
| 8 ☐ alive | 52 ☐ lively | 96 ☐ rejected |
| 9 ☐ alone | 53 ☐ gentle | 97 ☐ rough |
| 10 ☐ amiable | 54 ☐ glad | 98 ☐ sad |
| 11 ☐ amused | 55 ☐ gloomy | 99 ☐ safe |
| 12 ☐ angry | 56 ☐ good | 100 ☐ satisfied |
| 13 ☐ annoyed | 57 ☐ good-natured | 101 ☐ secure |
| 14 ☐ awful | 58 ☐ grim | 102 ☐ shaky |
| 15 ☐ bashful | 59 ☐ happy | 103 ☐ shy |
| 16 ☐ bitter | 60 ☐ healthy | 104 ☐ soothed |
| 17 ☐ blue | 61 ☐ hopeless | 105 ☐ steady |
| 18 ☐ bored | 62 ☐ hostile | 106 ☐ stubborn |
| 19 ☐ calm | 63 ☐ impatient | 107 ☐ stormy |
| 20 ☐ cautious | 64 ☐ incensed | 108 ☐ strong |
| 21 ☐ cheerful | 65 ☐ indignant | 109 ☐ suffering |
| 22 ☐ clean | 66 ☐ inspired | 110 ☐ sullen |
| 23 ☐ complaining | 67 ☐ interested | 111 ☐ sunk |
| 24 ☐ contented | 68 ☐ irritated | 112 ☐ sympathetic |
| 25 ☐ contrary | 69 ☐ jealous | 113 ☐ tame |
| 26 ☐ cool | 70 ☐ joyful | 114 ☐ tender |
| 27 ☐ cooperative | 71 ☐ kindly | 115 ☐ tense |
| 28 ☐ critical | 72 ☐ lonely | 116 ☐ terrible |
| 29 ☐ cross | 73 ☐ lost | 117 ☐ terrified |
| 30 ☐ cruel | 74 ☐ loving | 118 ☐ thoughtful |
| 31 ☐ daring | 75 ☐ low | 119 ☐ timid |
| 32 ☐ desperate | 76 ☐ lucky | 120 ☐ tormented |
| 33 ☐ destroyed | 77 ☐ mad | 121 ☐ understanding |
| 34 ☐ devoted | 78 ☐ mean | 122 ☐ unhappy |
| 35 ☐ disagreeable | 79 ☐ meek | 123 ☐ unsociable |
| 36 ☐ discontented | 80 ☐ merry | 124 ☐ upset |
| 37 ☐ discouraged | 81 ☐ mild | 125 ☐ vexed |
| 38 ☐ disgusted | 82 ☐ miserable | 126 ☐ warm |
| 39 ☐ displeased | 83 ☐ nervous | 127 ☐ whole |
| 40 ☐ energetic | 84 ☐ obliging | 128 ☐ wild |
| 41 ☐ enraged | 85 ☐ offended | 129 ☐ willful |
| 42 ☐ enthusiastic | 86 ☐ outraged | 130 ☐ wilted |
| 43 ☐ fearful | 87 ☐ panicky | 131 ☐ worrying |
| 44 ☐ fine | 88 ☐ patient | 132 ☐ young |

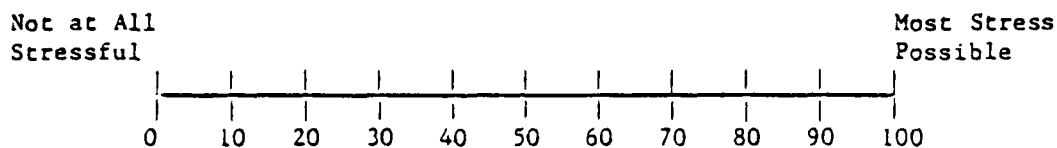
MARK ALL THE BOXES THAT DESCRIBE HOW YOU FELT WHILE YOU WERE ACTUALLY FIGHTING THE FIRE:

- | | | |
|--|--|--|
| 1 ☐ active | 45 ☐ fit | 89 ☐ peaceful |
| 2 ☐ adventurous | 46 ☐ forlorn | 90 ☐ pleased |
| 3 ☐ affectionate | 47 ☐ frank | 91 ☐ pleasant |
| 4 ☐ afraid | 48 ☐ free | 92 ☐ polite |
| 5 ☐ agitated | 49 ☐ friendly | 93 ☐ powerful |
| 6 ☐ agreeable | 50 ☐ frightened | 94 ☐ quiet |
| 7 ☐ aggressive | 51 ☐ furious | 95 ☐ reckless |
| 8 ☐ alive | 52 ☐ lively | 96 ☐ rejected |
| 9 ☐ alone | 53 ☐ gentle | 97 ☐ rough |
| 10 ☐ amiable | 54 ☐ glad | 98 ☐ sad |
| 11 ☐ amused | 55 ☐ gloomy | 99 ☐ safe |
| 12 ☐ angry | 56 ☐ good | 100 ☐ satisfied |
| 13 ☐ annoyed | 57 ☐ good-natured | 101 ☐ secure |
| 14 ☐ awful | 58 ☐ grim | 102 ☐ shaky |
| 15 ☐ bashful | 59 ☐ happy | 103 ☐ shy |
| 16 ☐ bitter | 60 ☐ healthy | 104 ☐ soothed |
| 17 ☐ blue | 61 ☐ hopeless | 105 ☐ steady |
| 18 ☐ bored | 62 ☐ hostile | 106 ☐ stubborn |
| 19 ☐ calm | 63 ☐ impatient | 107 ☐ stormy |
| 20 ☐ cautious | 64 ☐ incensed | 108 ☐ strong |
| 21 ☐ cheerful | 65 ☐ indignant | 109 ☐ suffering |
| 22 ☐ clean | 66 ☐ inspired | 110 ☐ sullen |
| 23 ☐ complaining | 67 ☐ interested | 111 ☐ sunk |
| 24 ☐ contented | 68 ☐ irritated | 112 ☐ sympathetic |
| 25 ☐ contrary | 69 ☐ jealous | 113 ☐ tame |
| 26 ☐ cool | 70 ☐ joyful | 114 ☐ tender |
| 27 ☐ cooperative | 71 ☐ kindly | 115 ☐ tense |
| 28 ☐ critical | 72 ☐ lonely | 116 ☐ terrible |
| 29 ☐ cross | 73 ☐ lost | 117 ☐ terrified |
| 30 ☐ cruel | 74 ☐ loving | 118 ☐ thoughtful |
| 31 ☐ daring | 75 ☐ low | 119 ☐ timid |
| 32 ☐ desperate | 76 ☐ lucky | 120 ☐ tormented |
| 33 ☐ destroyed | 77 ☐ mad | 121 ☐ understanding |
| 34 ☐ devoted | 78 ☐ mean | 122 ☐ unhappy |
| 35 ☐ disagreeable | 79 ☐ meek | 123 ☐ unsociable |
| 36 ☐ discontented | 80 ☐ merry | 124 ☐ upset |
| 37 ☐ discouraged | 81 ☐ mild | 125 ☐ vexed |
| 38 ☐ disgusted | 82 ☐ miserable | 126 ☐ warm |
| 39 ☐ displeased | 83 ☐ nervous | 127 ☐ whole |
| 40 ☐ energetic | 84 ☐ obliging | 128 ☐ wild |
| 41 ☐ enraged | 85 ☐ offended | 129 ☐ willful |
| 42 ☐ enthusiastic | 86 ☐ outraged | 130 ☐ wilted |
| 43 ☐ fearful | 87 ☐ panicky | 131 ☐ worrying |
| 44 ☐ fine | 88 ☐ patient | 132 ☐ young |

Rating of Events - General

1. What was the most stressful event in your life before today?

2. The scale below represents a range of how stressful an event might be. Put a check mark touching the line (✓) to indicate where you rate the most stressful event (from question #1).

STRESS SCALE

3. At what number value does the check mark touch the line? _____

4. Compared to the rating you gave in item 3 for the most stressful event, what number rating would you give the stress you experienced as a result of the fire fighting experience? _____

GENERAL INFORMATION QUESTIONNAIRE

NAME _____ DATE OF BIRTH _____

PRIMARY MOS _____ SEX _____ RANK _____

LENGTH OF SERVICE _____ EDUCATION LEVEL _____
(years) (months)UNIT _____
Company/BattalionSITUATION DESCRIPTION

1. WHAT WERE YOUR ACTUAL DUTIES DURING THIS FIRE FIGHTING OPERATION? PLEASE BE AS SPECIFIC AS YOU CAN:

2. HOW MUCH SLEEP DID YOU GET IN THE LAST 24 HOURS? _____

3. IS THIS FIRE FIGHTING OPERATION THE CURRENT MAJOR STRESS IN YOUR LIFE? _____ YES _____ NO

4. DID YOU FEEL YOU WERE IN A LIFE-THREATENING SITUATION? _____ YES _____ NO

USING THE SCALE BELOW, PLACE A CHECK MARK (✓) ON THE LINE TO INDICATE HOW YOU WOULD RATE YOUR ACTUAL DUTIES:

0	10	20	30	40	50	60	70	80	90	100
SAFE					LIFE-THREATENING					

5. HOW SUCCESSFUL DID YOU FEEL ABOUT GETTING THE JOB DONE?

USING THE SCALE BELOW, PLACE A CHECK MARK (✓) ON THE LINE TO INDICATE HOW SUCCESSFUL YOU FELT:

0	10	20	30	40	50	60	70	80	90	100
NOT AT ALL SUCCESSFUL					HIGHLY SUCCESSFUL					

6. WHAT TYPES OF PROBLEMS DID YOU ENCOUNTER?

7. HOW DOES THIS COMPARE TO YOUR IDEA OF A COMBAT SITUATION?

8. HOW WELL DO YOU THINK YOU COPEd WITH THE FIRE FIGHTING EXPERIENCE?

USING THE SCALE BELOW, PLACE A CHECK MARK (✓) ON THE LINE TO INDICATE HOW WELL YOU COPEd:

0	10	20	30	40	50	60	70	80	90	100
NOT WELL AT ALL				O.K.			GREAT			

9. SOME PEOPLE FIND CERTAIN THINGS HELPFUL IN DEALING WITH STRESSFUL SITUATIONS, LIKE:
- TALKING TO OTHERS WHO ARE IN THE SAME SITUATION,
 - THINKING OF OTHER THOUGHTS, LIKE WHEN THIS WOULD BE OVER,
 - SLEEPING WHENEVER POSSIBLE,
 - ETC...

PLEASE DESCRIBE THE THINGS YOU DID TO HELP YOU GET THROUGH THIS ENTIRE EXPERIENCE:

10. IN ADDITION TO WHAT YOU JUST LISTED IN THE PREVIOUS QUESTION, WHAT WOULD YOU HAVE FOUND HELPFUL IN HELPING YOU GET THROUGH THIS ENTIRE EXPERIENCE?

APPENDIX G
HEL RESEARCH REPORT

This appendix presents the report furnished by the US Army Material Command, Laboratory Command, Human Engineering Laboratory, Aberdeen, Maryland. The authors are MAJ James King, Ms. Linda Fatkin, and Dr. Gerald Hudgens. The subject of the report is the data collected from soldiers who fought fires in and around Yellowstone National Park during August and September 1988. The data was collected using the HEL questionnaire, Appendix F.

Stress Perceptions Among the Yellowstone Army Fire Fighters

**MAJ James M. King, MS Linda T. Fatkin,
& DR Gerald A. Hudgens**

**Soldier Performance & Combat Stress Teams
Behavioral Research Division (SLCHE-BR)
Human Engineering Laboratory
Aberdeen Proving Ground, MD 21005-5001**

In September 1988, the Concepts Analysis Agency (CAA) requested interagency participation in an effort to evaluate the level of stress experienced by the soldiers who had fought the fires at Yellowstone National Park and to begin to assess its impacts on performance. The ultimate goal of this effort is to provide improved human factors data for use in combat models by assessing the degree to which the stress of fighting a fire resembles the stress of fighting a human enemy. The evaluation team, which included two personnel from CAA, two from the Human Engineering Laboratory (HEL), one from the Walter Reed Army Institute of Research (WRAIR), and one from the Army Research Institute (ARI), felt that these fires afforded an outstanding opportunity to study stress reactions and to collect human factors data in a real operational setting which shares with combat the elements of personal danger and uncertainty. It was hoped that this data collection effort would serve as a pilot effort for future evaluations in which performance will be more firmly tied to the level of stress experienced by the soldiers involved.

The effects of stress on human performance have received extensive attention (Hockey, 1986). Stress-induced performance decrements have been demonstrated in soldiers performing combat-relevant tasks (Torre, 1966). The present HEL Stress Research Program (Hudgens, Torre, Chatterton, Wansack, Fatkin, and DeLeon Jones, 1986), a combination of in-house and contract efforts, is presently studying the links between psychological and physiological stress reactions and performance in a variety of settings. This program is well along in its effort to develop a psychological and physiological metric of stress which can be used to compare stress levels across situations. To date, studies conducted under this program have included a variety of situations, including viewing movies depicting stressful material, waiting while your spouse has outpatient surgery, waiting while your spouse has major surgery, taking an important medical school oral examination, taking a major written examination in medical school (Hudgens, Chatterton, Torre, Slager, Fatkin, Keith, Rebar, DeLeon-Jones, and King, in press), and firing in an interunit competitive marksmanship situation while being observed by ones fellow soldiers (Torre, Wansack, Hudgens, King, Fatkin, Mazurczak, and Myers, in preparation). We were, of course, very interested in the opportunity to study a new, and potentially highly stressful situation.

The HEL Stress Program assembled a two person team to participate directly in this evaluation of the Yellowstone fire fighting experience. They developed a questionnaire which was given to the soldiers, along with two standard psychological measures, to evaluate their stress levels during the fire fighting.

Method

Subjects: The subjects were 1100 soldiers, noncommissioned officers, warrant officers, and officers of the 9th Infantry Division Motorized and supporting units who participated in or supported the 1988 fire fighting operation at Yellowstone National Park. All subjects participated in the study voluntarily.

Survey: The survey used for this study contained adjective checklists (the Multiple Affect Adjective Check List-Revised or MAACL-R, Zuckerman and Lubin, 1985) to describe how they felt when filling out the survey and when actually fighting the fire, a rating of the stressfulness of the fire fighting (the Rating of Events Scale), ratings of the risk of their duties, a subjective performance assessment, and items addressing coping with the situation. Although the survey was customized for this application, nearly all of the scales had been used in one of the other studies which make up the HEL Stress Program. This was done in order to permit us to use the psychological portions of the stress metric which we are developing to assess the stressfulness of the Yellowstone fire fighting experience.

Procedures: The surveys were administered to soldiers in groups which nominally consisted of either company or battalion groupings. Soldiers were surveyed at Yellowstone National Park, Bozeman, Montana, and Fort Lewis, Washington after they had completed their fire fighting duties. The soldiers were provided with the survey, and a pencil, and were briefed on the purpose and content of the instrument. They were instructed to read the Volunteer Agreement Affidavit, and, if they agreed to participate in the study, proceed to fill out the rest of the questionnaire. Great care was taken to emphasize the voluntary nature of their participation in the study. Members of the evaluation team solicited comments from individuals who wished to elaborate on their responses or to address issues not covered in the surveys. The soldiers and their leaders were extremely cooperative throughout the data collection process.

Results and Discussion

Analysis of the data collected is ongoing, but we will present data on 1100 soldiers in the context of data obtained in the other HEL Stress Program studies. Thus we will tie the level of stress experienced by these soldiers to that experienced by the subjects in the other studies, thereby providing a standardized assessment of the stress experienced during the Yellowstone National Park operations relative to that experienced by other subjects in other situations. Data are also presented by Task Force and Rank. The data presented in the figures which follow are displayed in a mean (the bar) plus one standard error (the capped vertical bar) format. On each of the figures shown, the overall F ratio for group differences is significant at $p < 0.004$ or better.

The Ratings of Events for the situations studied to date are depicted in Figure 1. The groups are spouses of patients undergoing abdominal surgery, medical students taking a major written examination, combined surgery and examination control groups, soldiers firing in a noncompetitive marksmanship setting, soldiers firing in a highly competitive marksmanship setting, and the Yellowstone fire fighters. They had been asked to rate the stressfulness of their experiences on a scale of 0 to 100. These results indicate that the soldiers fighting the Yellowstone fires experienced a stress level on the high end of the moderate range, comparable to that experienced by spouses of patients undergoing major abdominal surgery, for instance. This abdominal surgery group contains some of the most stressed individuals we have studied to date.

Figure 2 displays the event ratings broken out by the task forces (TF) into which the Yellowstone fire fighters were organized (TFs A through E), or into which they could be logically placed (TF F, the aviation personnel). Except for TF F, the demographics of the TFs were similar. Note that TF C had by far the highest event rating we have recorded to date. This TF was extensively involved in structure protection during their period in Yellowstone.

The MAACL-R scores for Anxiety (Figure 3), Depression (Figure 4), Hostility (Figure 5), Positive Affect (Figure 6), and Sensation Seeking (Figure 7) broken out by TF reveal that TFs C and F, although generally at opposite ends of the response spectra, are clearly distinguishable from the other TFs on the measures. This was also true for ratings of the Life Threatening aspects of the duties (Figure 8), and for Coping Efficacy (Figure 9), but is less clear for our Success, our subjective measure of performance effectiveness (Figure 10).

A stepwise multiple regression analysis was used to predict Success (see Figure 10). The final model, which was based on 860 cases, involved as variables Length of Service, Life Threatening (see Figure 8), Coping Efficacy (see Figure 9), Anxiety (see Figure 3), Hostility (see Figure 5), Positive Affect (see Figure 6), the Rating of Events (see Figures 1 and 2), and TF. The multiple R was 0.435, which accounted for 18.5% of the variance in the performance rating. The model itself was highly significant ($p < 0.001$).

It is also worth noting that the soldiers perceived the situation differently from their leaders. This point is made rather strongly by Figure 11, which presents the Rating of Events by rank, and by Figure 12, which displays our subjective performance rating, Success, by rank.

The comments made by the soldiers bear on the issue of using operations such as the Yellowstone National Park fire fighting experience to as a "laboratory" model of combat. Roughly 40% of the subjects were either unwilling or unable to compare their Yellowstone experience to either their experiences in or their ideas of combat. Those willing to make such a comparison noted that the Yellowstone operation shared several common factors with combat. These included the deployment process, family separation, the need for leadership, teamwork, and discipline at the unit level, and the requirement to manage individual differences in stress responses. Other common factors included the sustained nature of the work, with alternating periods of intense activity and boredom, unfamiliar terrain with limited ingress and egress routes and dangerous animals, the physical strain of fire fighting and the long (10 to 14 mile) marches to fire fighting sites, complications arising from communications, and the unpredictable nature of the fire itself.

Based on these results, we will prepare a revised survey to be used in conjunction with other potentially stressful operations involving soldiers. Our experiences to date suggests that much valuable information relevant to the behavior and performance of soldiers and their leaders in combat can be collected in situations such as that offered by the Yellowstone National Park fires because, unlike training, these situations involve real hazards, real dangers, and real consequences in a real world setting. The fire, unlike a human enemy, is neither alive nor is it motivated to defeat the soldiers, but it is, none the less, a dangerous and unpredictable foe. These findings further suggest that it is advisable to maintain a team to collect data from soldiers in situations analogous to the Yellowstone operation. With the addition of more performance data to the collection effort, such undertakings will be able to provide a

steady flow of information on human performance in operational settings to the modeling community.

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Figure 1

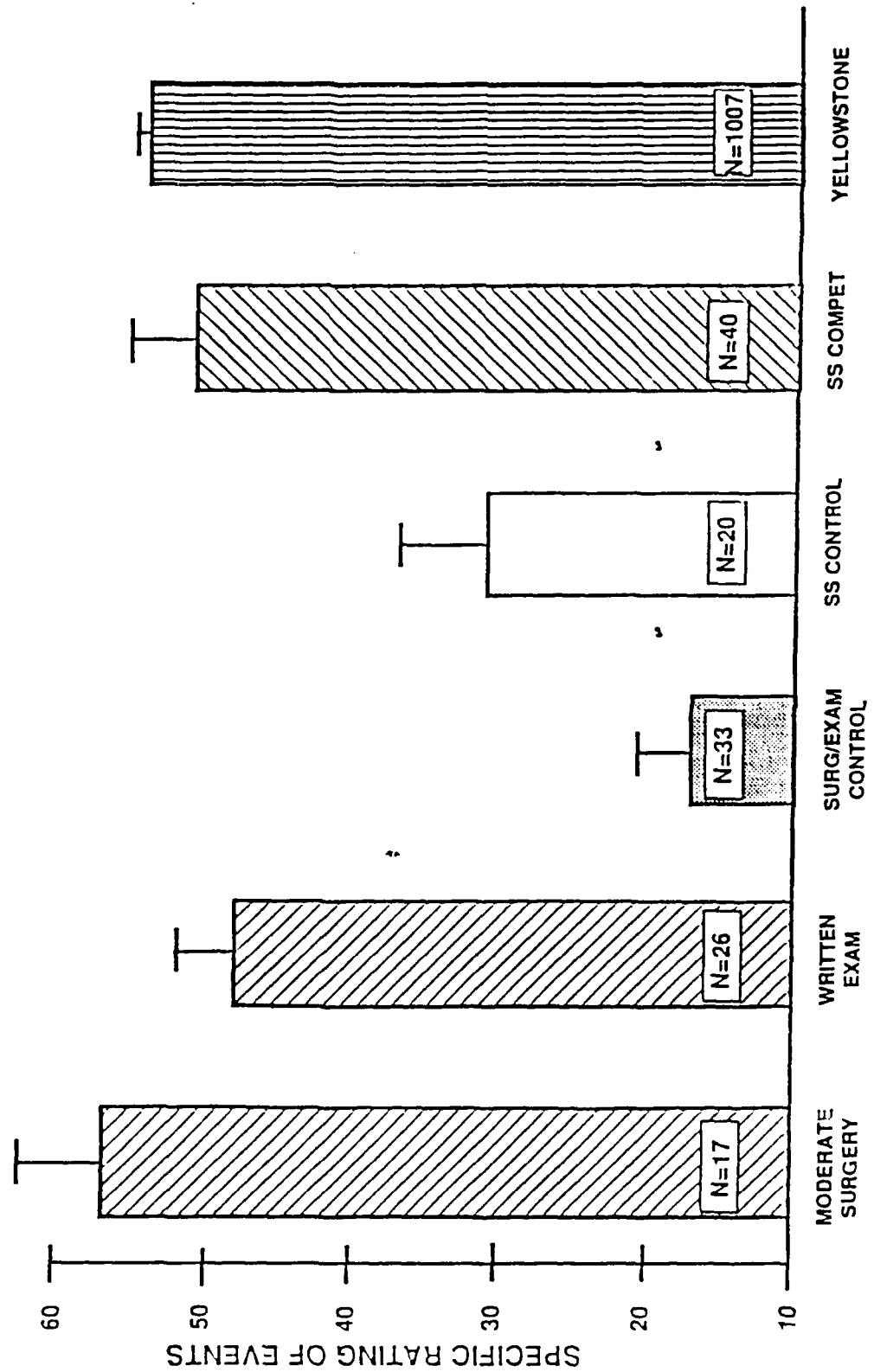
COMPARATIVE SPECIFIC RATING OF EVENTS
POST STRESS

Figure 2

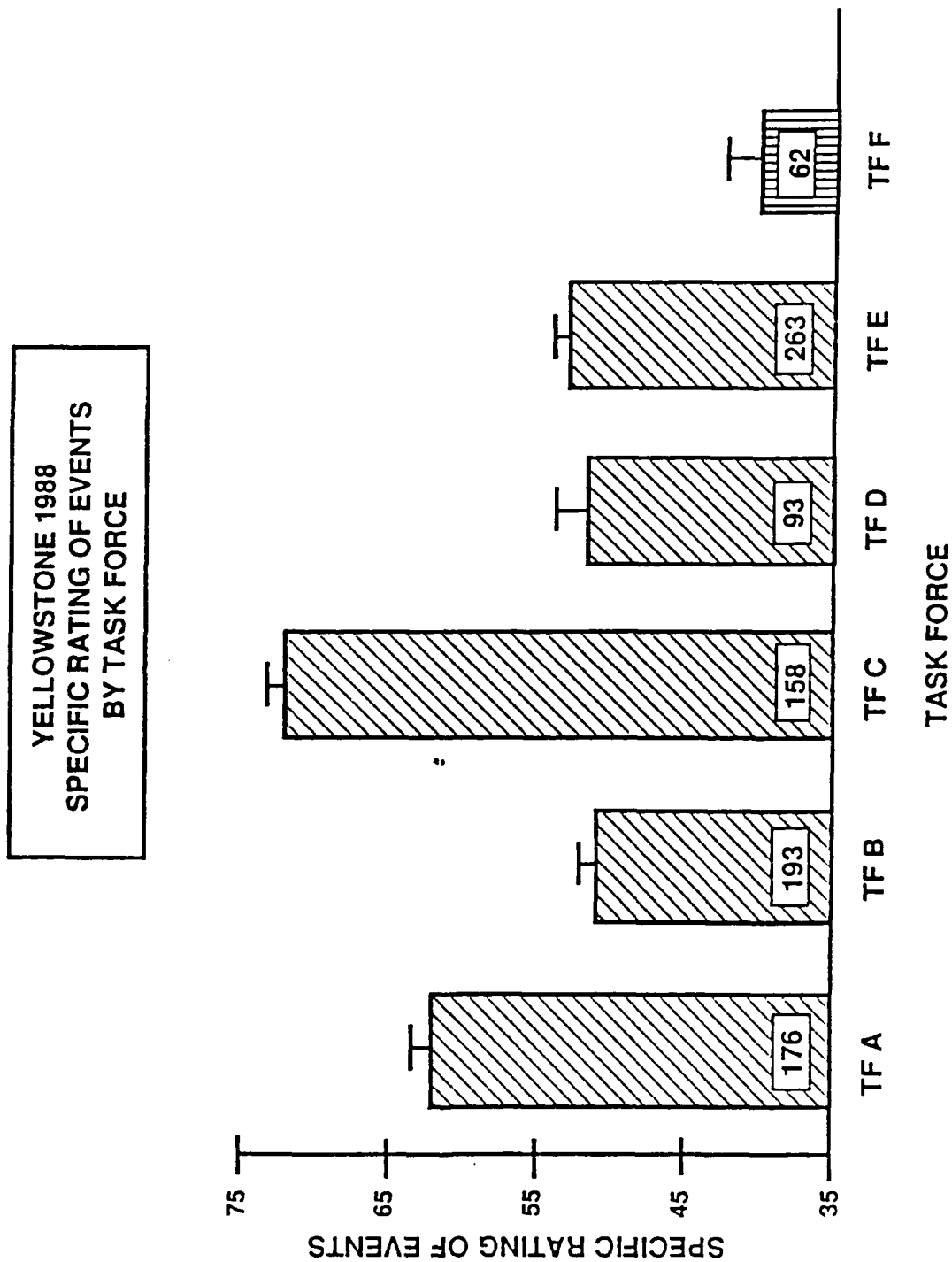


Figure 3

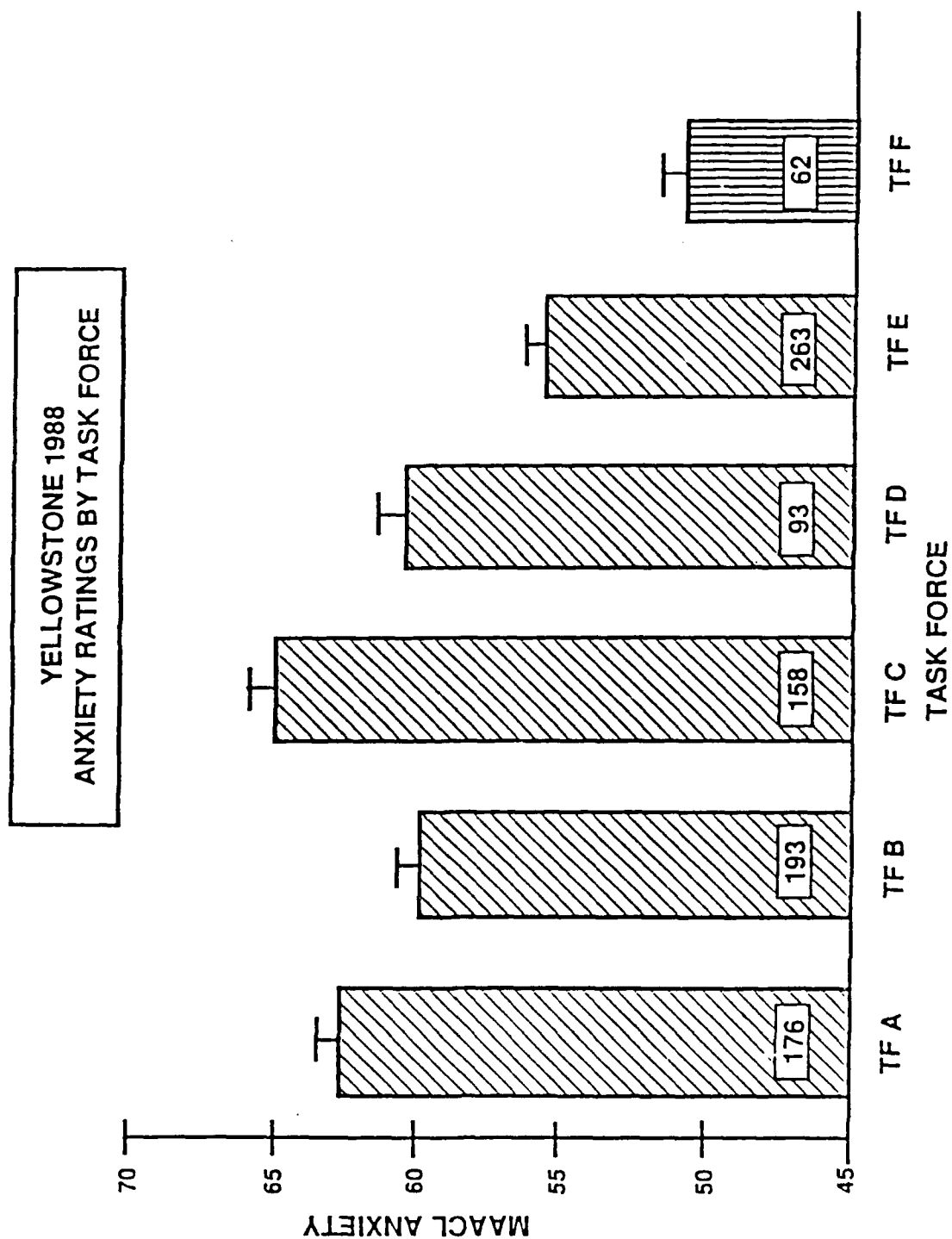


Figure 4

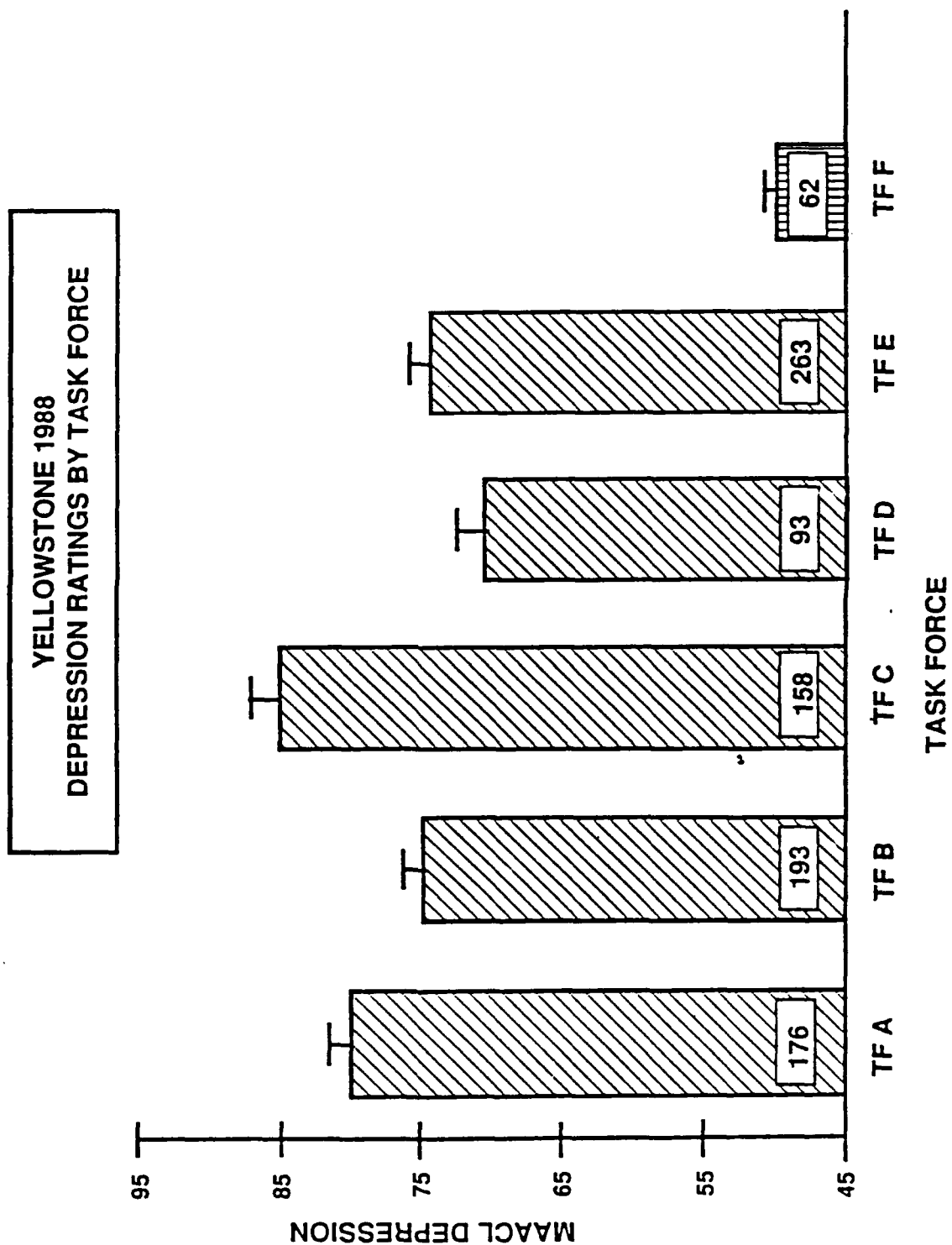


Figure 5

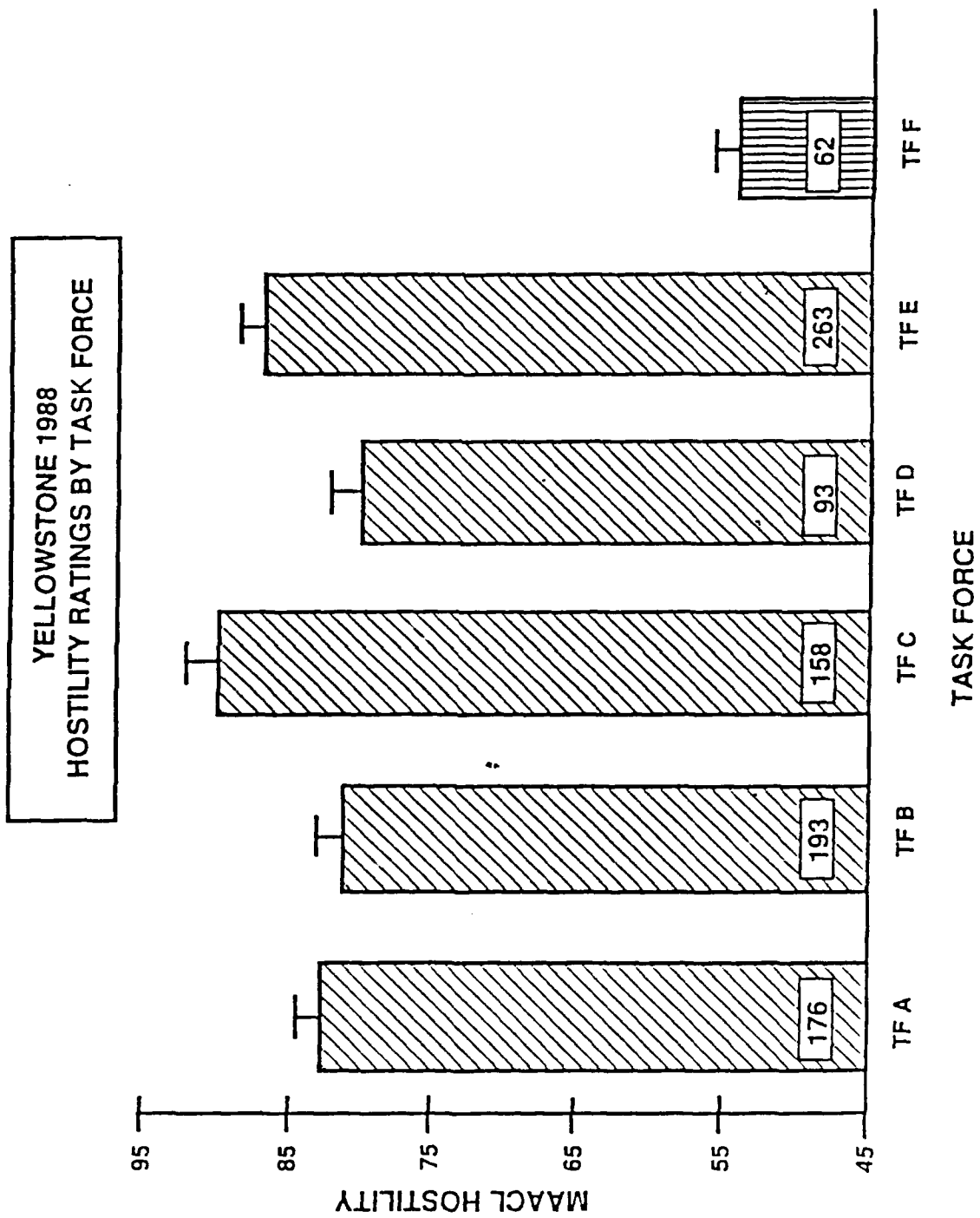


Figure 6

YELLOWSTONE 1988
POSITIVE AFFECT RATINGS TASK FORCE

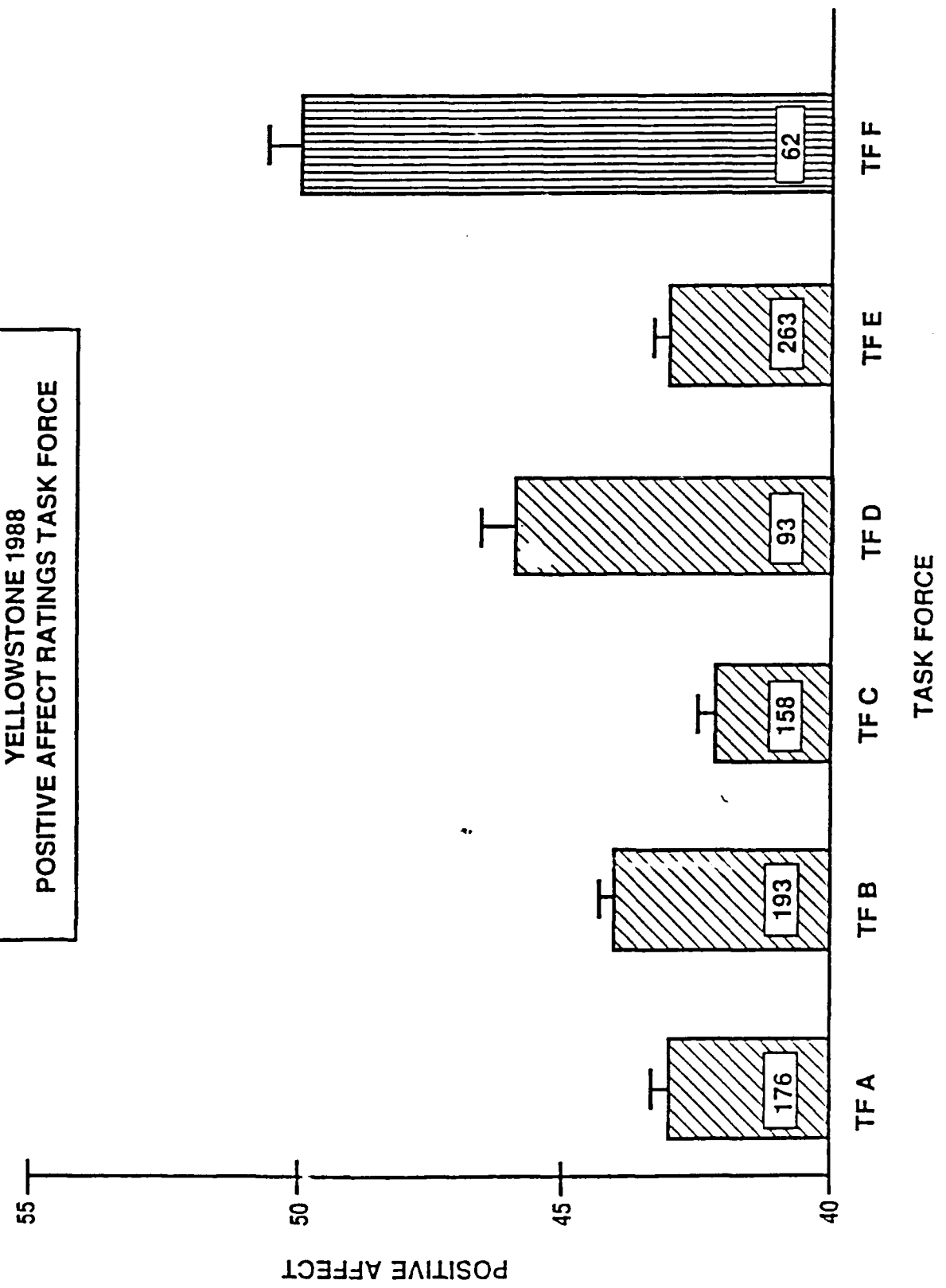


Figure 7

YELLOWSTONE 1988
SENSATION SEEKING RATINGS BY TASK FORCE

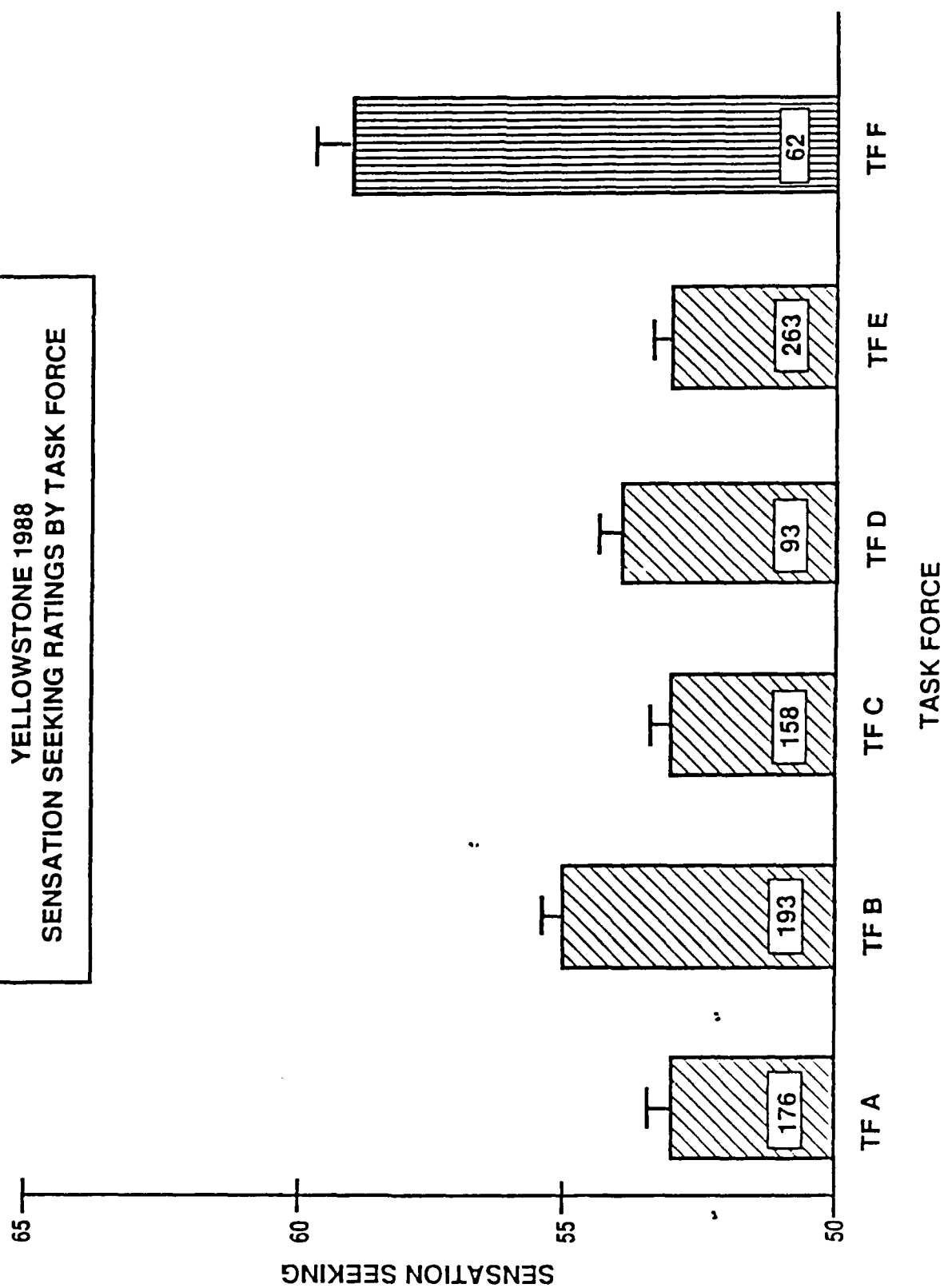


Figure 8

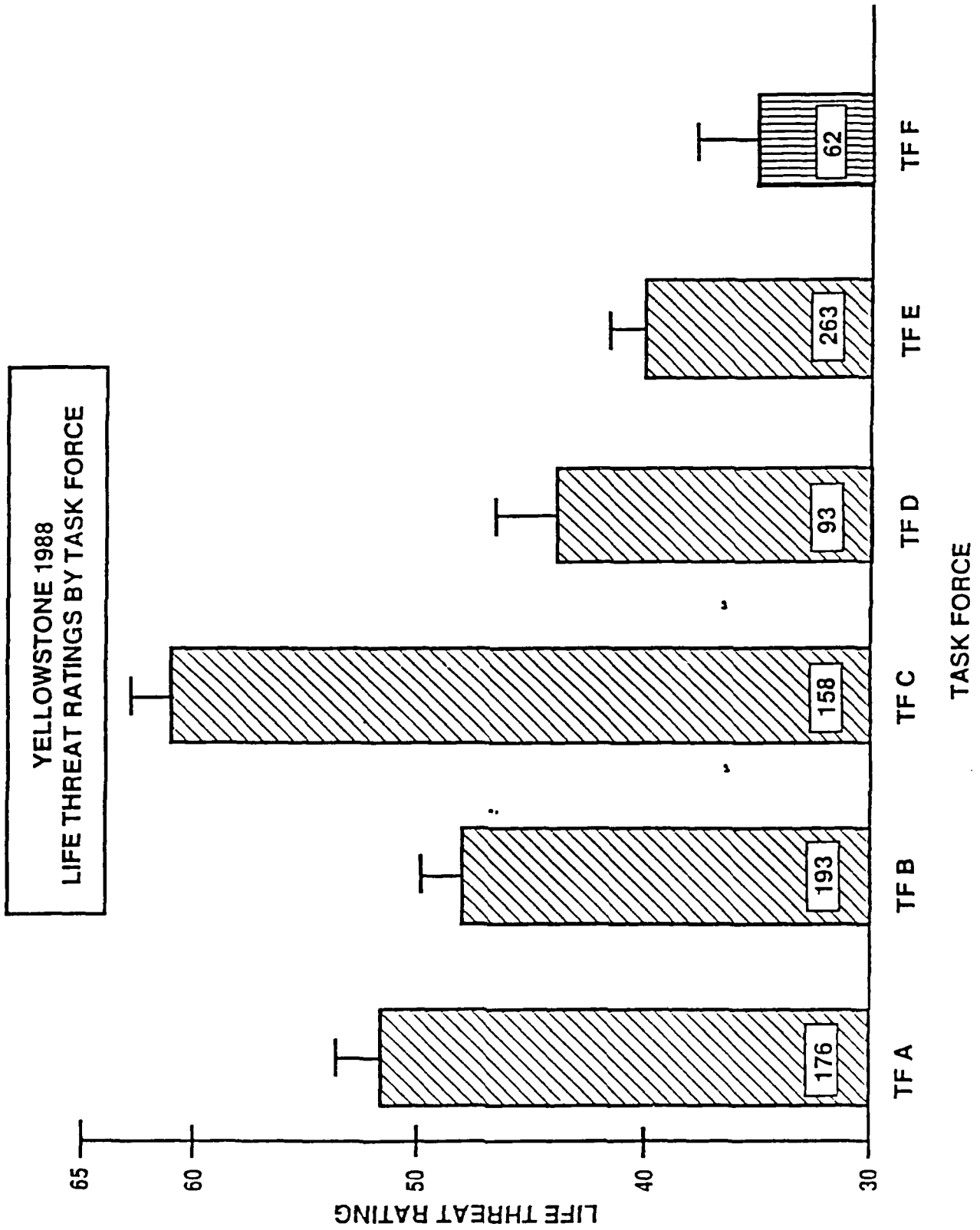


Figure 9

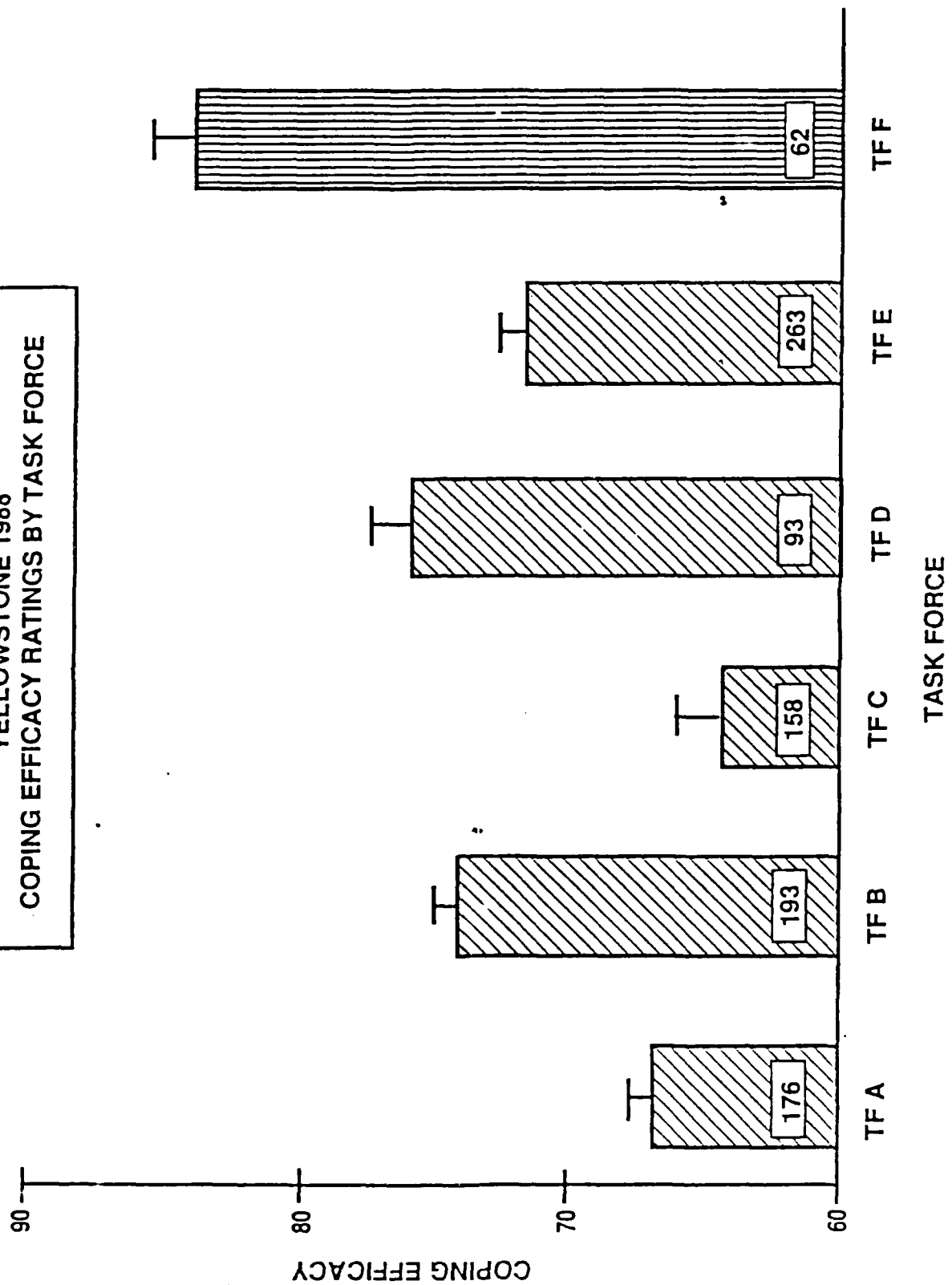
YELLOWSTONE 1988
COPING EFFICACY RATINGS BY TASK FORCE

Figure 10

YELLOWSTONE 1988
SUBJECTIVE PERFORMANCE RATINGS BY TASK FORCE
("HOW SUCCESSFUL DID YOU FEEL...?")

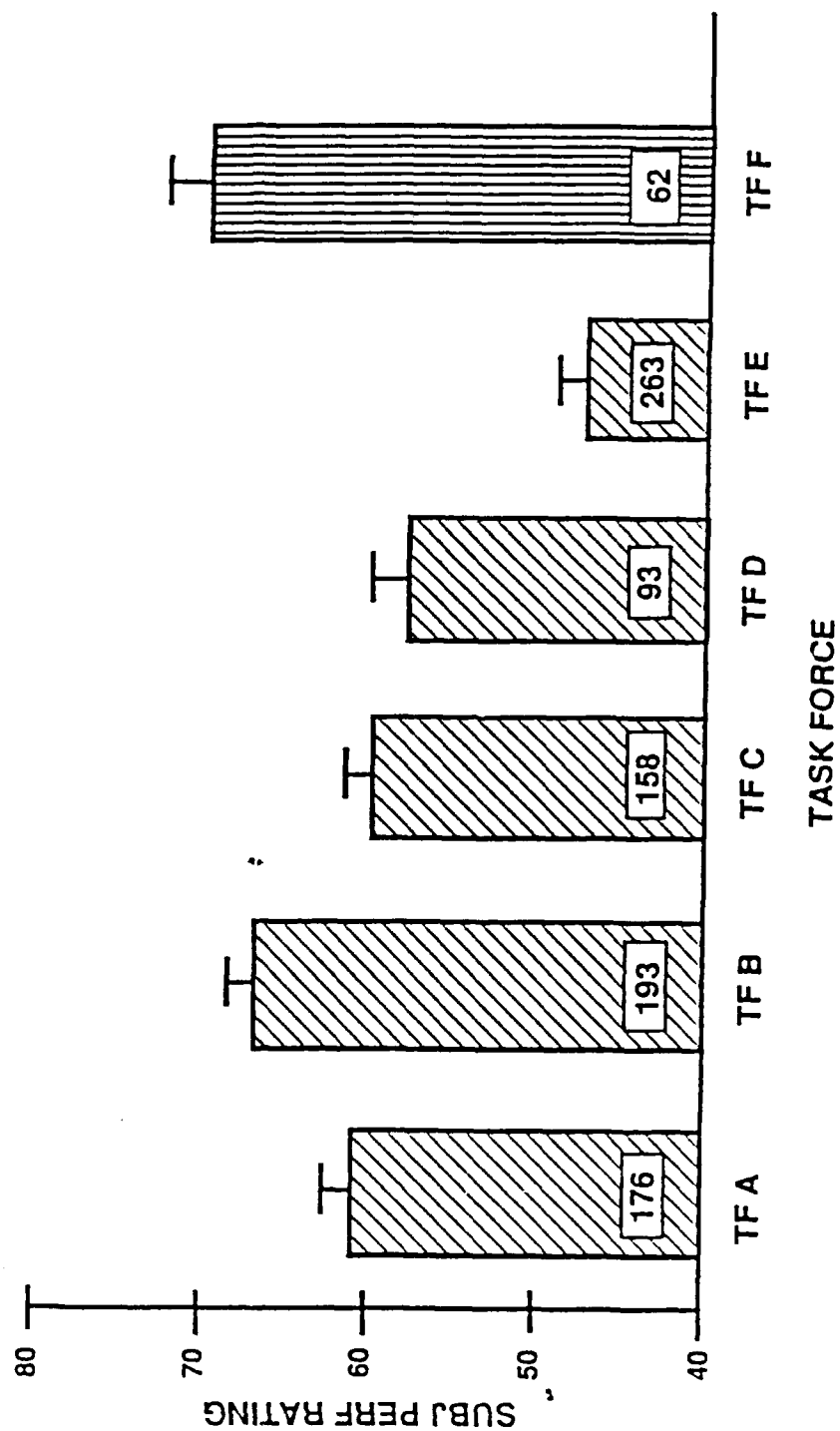


Figure 11

YELLOWSTONE 1988
SPECIFIC RATING OF EVENTS
BY RANK

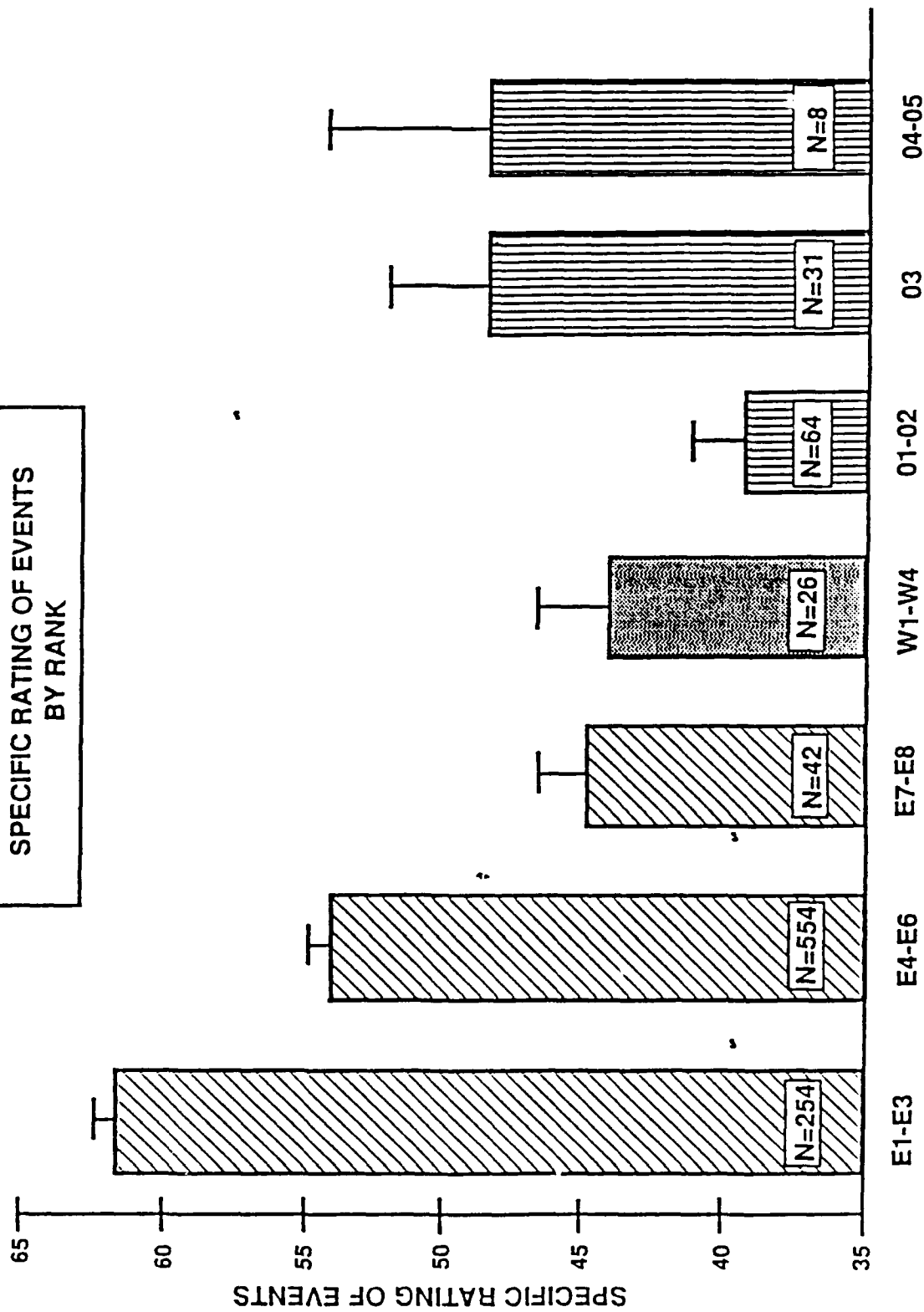
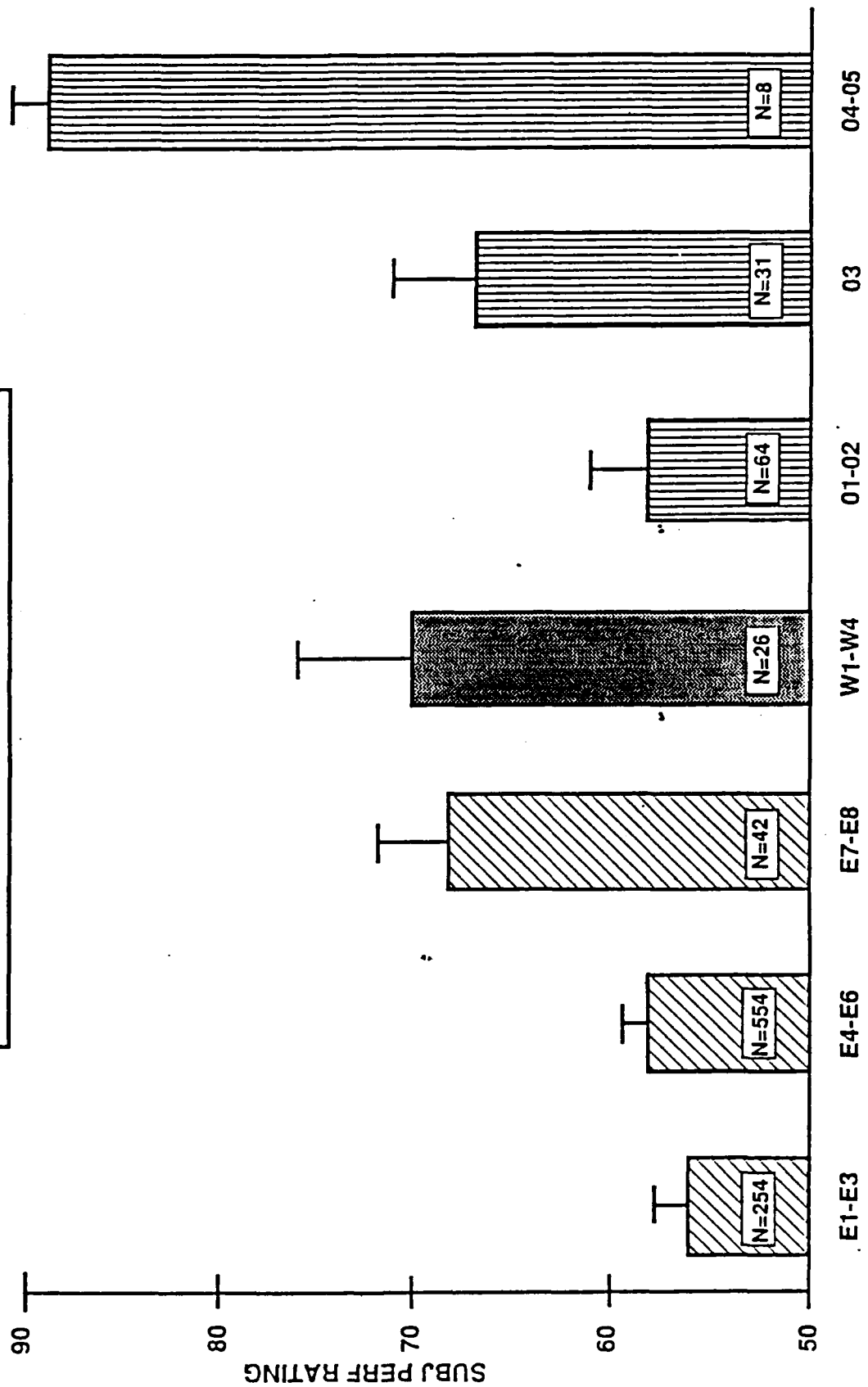


Figure 12

YELLOWSTONE 1988
SUBJECTIVE PERFORMANCE RATINGS BY RANK
("HOW SUCCESSFUL DID YOU FEEL ...?")



APPENDIX H

SEQUENCE OF EVENTS

H-1. INTRODUCTION. Because of the need for rapid response, the usual sequence of study events (coordinate study directive, develop study plan, brief and gain approval of study directive and study plan, collect and analyze data, brief and report results) was not followed. This appendix explains the procedures that were actually used.

H-2. STUDY PLAN DEVELOPMENT. On Wednesday, 21 September 1988, the Director, CAA, gave verbal approval of a study to collect the maximum amount of data on soldier performance, fatigue, and stress related to forest fire fighting in the remaining time before the fire fights were won and the soldiers totally redeployed. Initial coordination with the ODCSOPS action officer revealed that the early winter snows had become powerful allies of the fire fighters. The fires were going out even more rapidly than originally projected. The last group of the four battalions of Army soldiers was scheduled to stand down by Sunday, 25 September. The Marines, who had only recently arrived, would stay somewhat longer. Since the Yellowstone Joint Task Force was under the operational control of the Army, acting for the Joint Chiefs of Staff, we would be allowed to study the Marines.

a. There was no time for additional literature searches or for a team with no previous experience in this type of data collection to develop measurement instruments. Therefore, a team of human performance and stress measurement research experts (see Appendix A for the list of team members and affiliations) was created by a series of telephone discussions with the Technical Director and SRL Director at ARI, several contacts at HEL, and the Chief of the Behavioral Biology Department at WRAIR. CAA asked for human research expertise and data collection instruments. In exchange, CAA offered the unique opportunity to collect data in a real operational environment, on subjects in which the other agencies were already interested. There was also no time for developing a Memorandum of Understanding which could be signed by each of the agencies involved. A limited verbal agreement as to responsibilities and levels of involvement was determined during these initial discussions.

b. A verbal study plan with organizational responsibilities was created the first day via telephone discussions among members of the team. In the limited time available, it would not be possible to develop objective measurements of soldier performance, but both ARI and HEL were experienced in developing questionnaires for subjective assessments. The ARI task force member developed an entirely new set of questions, including questions suggested by CAA and WRAIR members. As well as questions about continuous operations, sleep loss, fatigue in which ARI are interested, this questionnaire had questions about weight loss, food, and water availability in which the medical community has an interest. HEL task force members created a second set of questions. So that they could compare the soldiers' stress levels with other situations, HEL used some items which they had used previously to measure the amount of experienced stress, including the Multiple Affect Adjective Check List-Revised (MAACL-R). They also included some new items created specifically for the forest fire fighting situation.

c. We knew that there were four battalions of soldiers from the 9th Infantry Division fighting fires; we did not know exactly how many soldiers that might be, but we guessed around 2,000. Since there so many different activities taking place and so many different experiences about which we might have an opportunity for data collection, we decided that we would need at least 1,000 questionnaires, perhaps as many as 1,500 to 2,000. Since copy machines were unlikely to be standard equipment in Yellowstone, we decided we should make the copies here and take them with us. Since the distance between ARI and HEL is about a 2-hour drive, the team members from these agencies decided that it would be impossible to combine the questionnaires this time. That meant that each questionnaire had to have its own separate volunteer consent form.

d. Because some kinds of qualitative information are difficult to capture in a questionnaire, we planned to interview soldiers whenever we found an opportunity. Tape recorders were needed for the interviews--fortunately, CAA had some onhand. Other information, such as task force composition and the dates they were committed to the fire, would come from the After Action Report written by the Joint Task Force, Yellowstone, and obtained from ODCSOPS.

e. We knew better than to try to make specific plans about how we would administer the questionnaires (either location or size of groups) prior to our arrival; we would need to depend upon the advice and help of the JTF. The only plan we made was one to try to avoid effects of sequencing bias in the questionnaires. Since we had two questionnaires, we decided to divide each set of soldiers into two separate groups--one would get the ARI questionnaire first and the HEL questionnaire second; the other group would get the questionnaires in the reverse sequence.

f. Both questionnaires were finalized and reproduced the second day, Thursday, 22 September. WRAIR task force members spent that day collecting and checking their activity monitors. With the actigraphs, they planned to collect objective measures of the frequency and duration of the Marine fire fighters' sleep periods for comparison with the subjective estimates collected by ARI and HEL. However, ODCSOPS notified us that evening that the fires were going out so fast that even the Marines would be standing down immediately. Since the actigraphs would not be used, only one of the WRAIR members (COL Dan Redmond) actually accompanied the rest of the task force to Yellowstone.

g. The team arrived in the afternoon of 23 September. We had enough pencils for several companies, two sets of about 1,000 questionnaires, six microcassette recorders for interviews, and miscellaneous supplies including pencil sharpeners. We introduced ourselves to each other at the Salt Lake City Airport while we awaited the flight into West Yellowstone, Montana, the location of the headquarters of the Department of Defense Joint Task Force (JTF), Yellowstone. The only passengers on the 12-passenger airplane were the 6 members of the fire fighting task force, some Forest Service Rangers, a couple of civilian fire fighters returning after some R&R (rest and recuperation), and an Army civilian helicopter computer repairman who was going in to work on the Chinooks (CH-47 helicopters).

H-3. DATA COLLECTION PHASE. As should be expected with data collection in an operational environment, the only aspects of the data collection phase that were as expected were that we did not have laboratory conditions for questionnaire administration, and we had little choice as to when, where and to whom we would administer the questionnaires. If we had been there during the worst of the fires, we would have been able to administer questionnaires to specific groups--those that actually fought blazing fires after having adequate rest, those that fought similar fires but perhaps did not have enough time for sleep, and those that performed heavy, difficult physical tasks but did not actually fight a fire. By the time we arrived, there were no Marine or Army soldiers on the fire lines. Two Army battalions had already redeployed, one battalion was preparing to move to Bozeman, Montana, for redeployment, and another was standing down in a Yellowstone recreational area for later redeployment from Bozeman. The Marines were waiting for availability of redeployment transportation assets, standing down in their tent camps. Since we could not target specific groups, we asked for all Army soldiers. Since the Marines arrived so late and were already preparing for redeployment, we decided not to include them.

a. Battalion 1. Since a very full day was planned for Saturday, 24 September, we met for breakfast at 0600, leaving immediately afterward for Grant Village in Yellowstone National Park, where we were to meet our first military fire fighters. They were housed in the Grant Village cabins and lodge while waiting for transportation back to Fort Lewis. Because the fire had closed the road between Old Faithful and Grant Village, we had to take the long way around, past Yellowstone Lake. Although we arrived about 1030, the Forest Service was preparing to present a plaque when we arrived, so it was nearly 1300 by the time we started administering the questionnaires in the recreation area of the lodge. It took quite a while for the unit to organize everyone and for the Forest Service to perform the ceremony. While we waited, we recorded interviews with several soldiers. In this group, the noncommissioned officers (NCOs) seemed particularly interested in talking to us. Since the commander, Major Robershotte, had not known we were coming, he had not been able to plan for both diversions (the ceremony and our questionnaires) from the required work of turning in Forest Service equipment and packing up to go home. Since his secondary specialty is operations research, he understood both the difficulty of getting a project like this started and the desire to do it. He was especially interested and helpful. Once the award ceremony was over, he set up a sequence for the troops, and his company commanders kept another group moving in as soon as another finished. They assembled, a company at a time, in the recreation area of the lodge and used whatever flat surface they could find as a table--a few were able to sit around coffee tables; the rest stood around the ping pong table and the balcony rails, or sat on the stairs. At the rate they arrived, we finished quickly (by about 1530), stopped at a park grocery shop, and had a picnic lunch of peanut butter and jelly, chips, and other junk food before heading for Bozeman.

b. Battalion 2. We arrived at the field house at the University of Montana in Bozeman, Montana, at sundown that evening. The next battalion of soldiers was temporarily housed there until their flight home (scheduled for midnight). Again, since the battalion commander, Lieutenant Colonel Mackey, did not know of our expected arrival, no preparations had been made. He welcomed us anyway and put someone in charge of collecting the soldiers in

the gymnasium for us. A large group of soldiers had been allowed to go to a movie at a nearby theater, and another group was watching a video movie. Although some of the video viewing group volunteered to take our questionnaires, most of the soldiers who took them from this battalion were the ones who were already sitting around in the gym leaning on their sleeping bags and reading, playing cards, or sleeping. The floor functioned as both the soldiers' chairs and their tables for the questionnaire. This group seemed more tired than the first one and not particularly interested in being interviewed--maybe it was us; by now we had been on the go for about 14 hours, and we were not yet acclimated to the altitude of 6,500 to 10,000 feet. Whatever the reason, we only got one good interview, an officer this time. After a late night bowl of soup and dessert, we started our 2-hour moonlit drive back to West Yellowstone. We discovered why everyone carries a rifle in the West--we found a wounded deer in the middle of the road which had been hit by a car, and there was nothing we could do, either to help or to put it out of its misery.

c. **The Aviators.** Sunday, 25 September, was an easy day for the study team. We talked to the medical commanders at the field hospital (set up at the West Yellowstone Airport) about the medical situation during the fire fighting; they felt there were fewer cases of sickness and injury than should have been expected. We did not assemble the medical soldiers for the questionnaires; the questionnaire designs were not appropriate for them. Since we had been told that the Army helicopters had been used in fighting the fires, we did give the questionnaires to the aviators and the aviator mechanics. The facilities were the best we had either at Yellowstone or at Fort Lewis--a party room in a West Yellowstone motel which had tables and chairs.

d. **Battalions 3 and 4.** Since notice of our arrival and requirements for subjects reached neither of the commanders of the first two battalions, we coordinated directly with the brigade commander, Colonel Van Alstyne, for the Fort Lewis phase. He arranged for the availability of the soldiers in the battalions which had already returned to Fort Lewis. The site assigned for giving the questionnaire was a theater, with enough seats that an entire company could be seated at once. It seemed ideal at first. The problem was having two questionnaires, with one having to be handed back before they received the other. If we had not needed two separate volunteer consent forms, one for each questionnaire, we could have stapled the questionnaires together, with the ARI questionnaire on top for one half of the company, and the HEL questionnaire on top for the other half. As it was, some soldiers finished the first questionnaire and started trying to exchange them for the second, while other soldiers, sitting in the middle of the long rows of seats, were asking questions. The atmosphere became hectic for those who were still working on the first one. Without a microphone, it was nearly impossible for them to hear group directions, so there were a lot of questions. If we had scheduled them in smaller groups, it would have been easier for everyone concerned.

e. There is something the study team believes we managed to hide from the soldiers at the time of the questionnaire administration in Fort Lewis. An hour before the first ones were handed out in the theater, we had no questionnaires and no sharpened pencils. When we flew out of West Yellowstone early that morning, on the twice-daily, 12-passenger plane, we

did not know that the majority of our luggage did not go with us--no questionnaires, no pencils, no pencil sharpeners. By the time it was verified that they were still in West Yellowstone (the plane is too heavy for that altitude with both a full load of passengers and a full load of luggage), it was 1130, with soldiers scheduled for 1330. We quickly rented our vans, rushed to a commercial reproduction center near Fort Lewis, and bought out the pencils in a nearby stationery store while the first questionnaires were reproduced. By borrowing an electric sharpener, which stopped every time it got hot, and by running a shuttle service between the reproduction center and the Fort Lewis theater, we managed to have everything we needed for each new group of soldiers. Sometime that evening, we realized no one had had lunch.

H-4. SUMMARY. In this appendix we described the development of the study plan, including the reason for administering two separate questionnaires. And we described the questionnaire administration. We think it is important that the reader understands something about the circumstances in which the questionnaires were taken, and that anyone planning a similar study will plan to expect the unexpected.

APPENDIX I

ADDITIONAL DATA FROM THE HEL QUESTIONNAIRE

I-1. This appendix provides additional charts of data collected on the HEL questionnaire, Appendix G. The first two, Coping Efficacy and Subjective Performance (Figures I-1 and I-2) are from a rating scale of 0 to 100. Figure I-1 shows a similar pattern, but reversed from the patterns in the charts in Chapter 5. Task Force C, followed by TF A is the lowest, while TF F is the highest--the E1-3 group is the lowest on the rank portion. Figure I-2 is slightly different--the same differences are seen between TF C, TF A, and TF F, and among the various ranks, but now TF E shows up as the lowest. Although the questions are somewhat related, the first question, coping efficacy, asked the soldiers about the *fire fighting experience* after asking them about problems encountered and how they thought it compared to a combat situation. The second question, subjective performance, asked specifically about how successful they felt about *getting the job done*. Task Force E is the one that had very little fire fighting. It is possible that TF E soldiers did not work as hard at their duties of fuel reduction (or "park beautification," as they called it) as the others did at fighting fires, so that they did not feel that they were as successful at getting the job done.

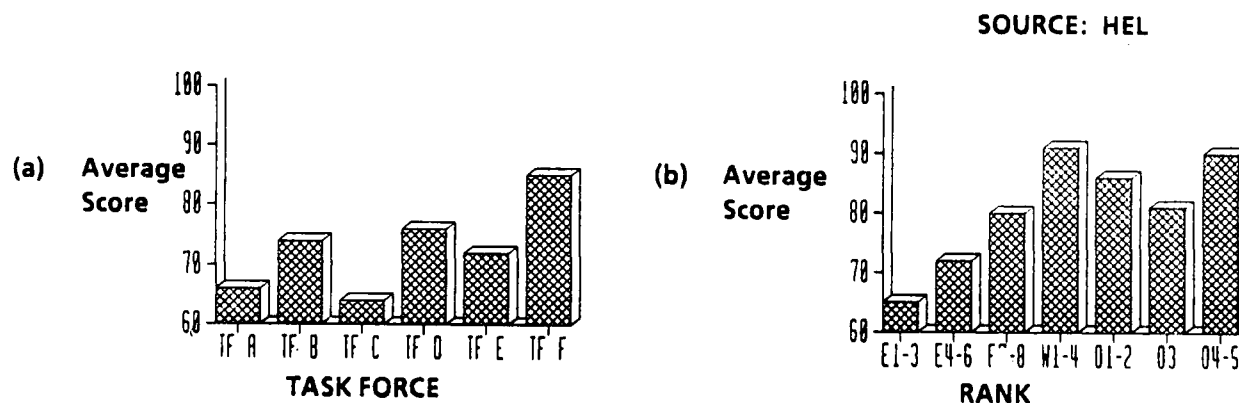


Figure I-1. Coping Efficacy

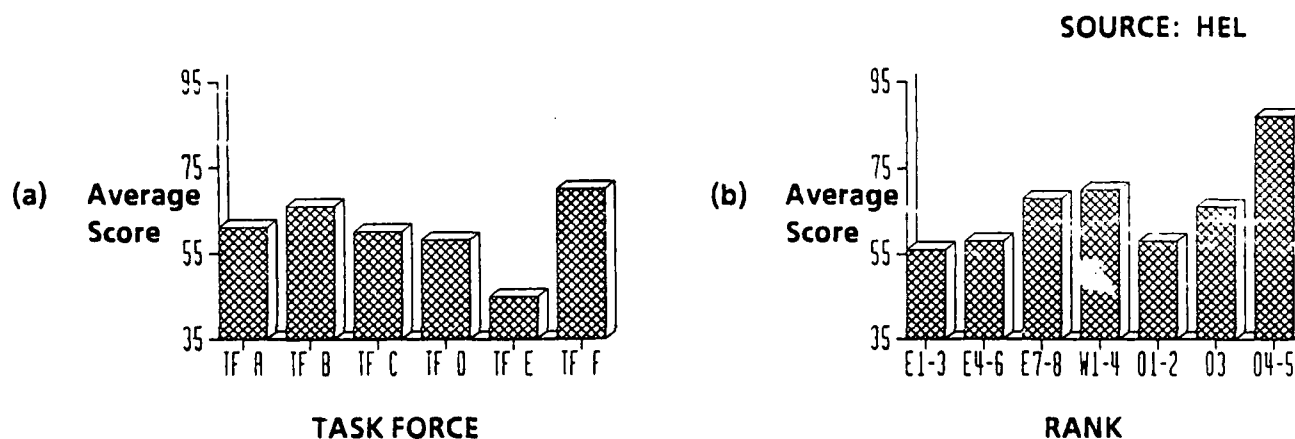


Figure I-2. Subjective Performance

I-2. The next two figures are charts from the MAACL-R. The first (Figure I-3), Positive Affect, is a measure of the soldiers' positive feelings about themselves. The expected pattern, reversed from those in Chapter 5 appears. We do not know the cause of these results. They could be from any combination of several factors, but seem to be correlated with the cumulative effects of fighting forest fires. The same pattern as those in Chapter 5 is shown in Figure I-4, but the differences between task forces and between ranks are less than the differences between situations shown on the situation portion. Again, we have no explanation except that research tells us that anxiety is higher when the source of stress is ambiguous. At Yellowstone, the sources of stress were relatively clear, with fire and physical exertion being the two major stressors. Therefore, the stress caused by anxiety in fire fighting seems to cause less dramatic differences.

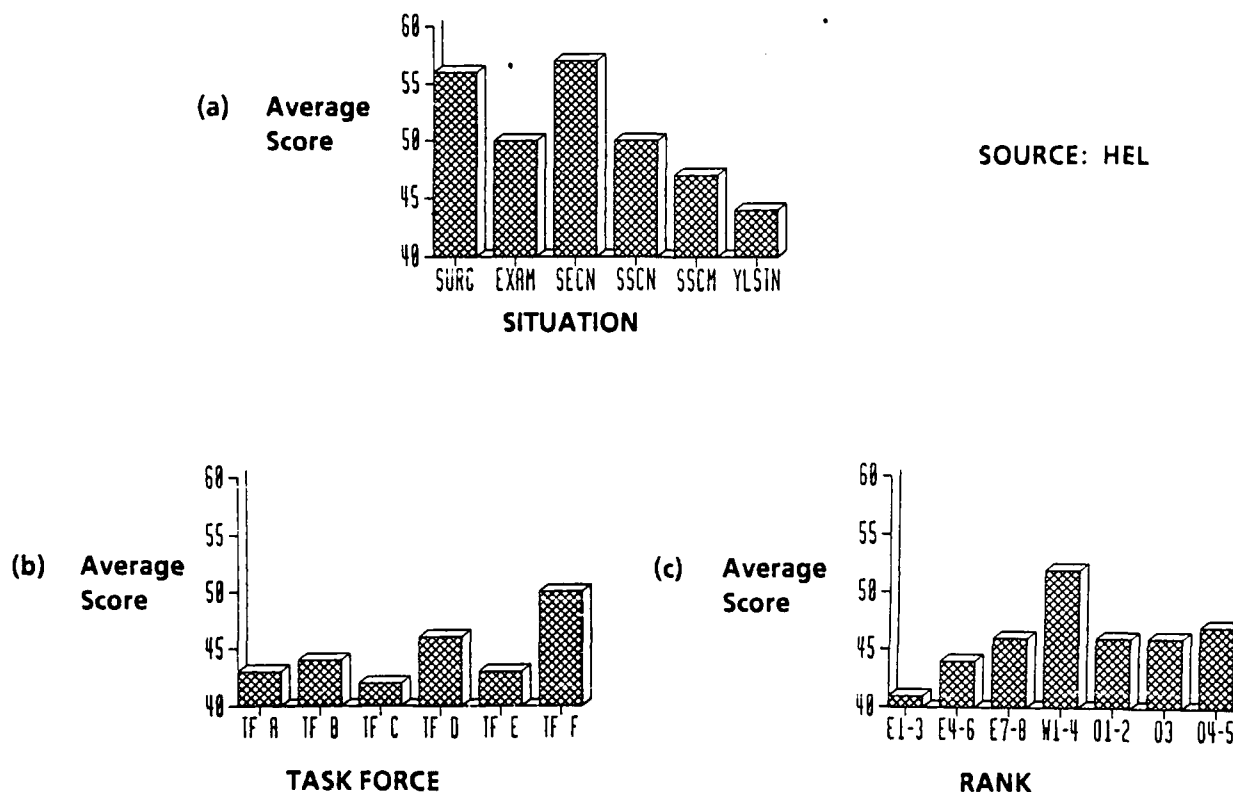


Figure I-3. Positive Affect, from the MAACL-R

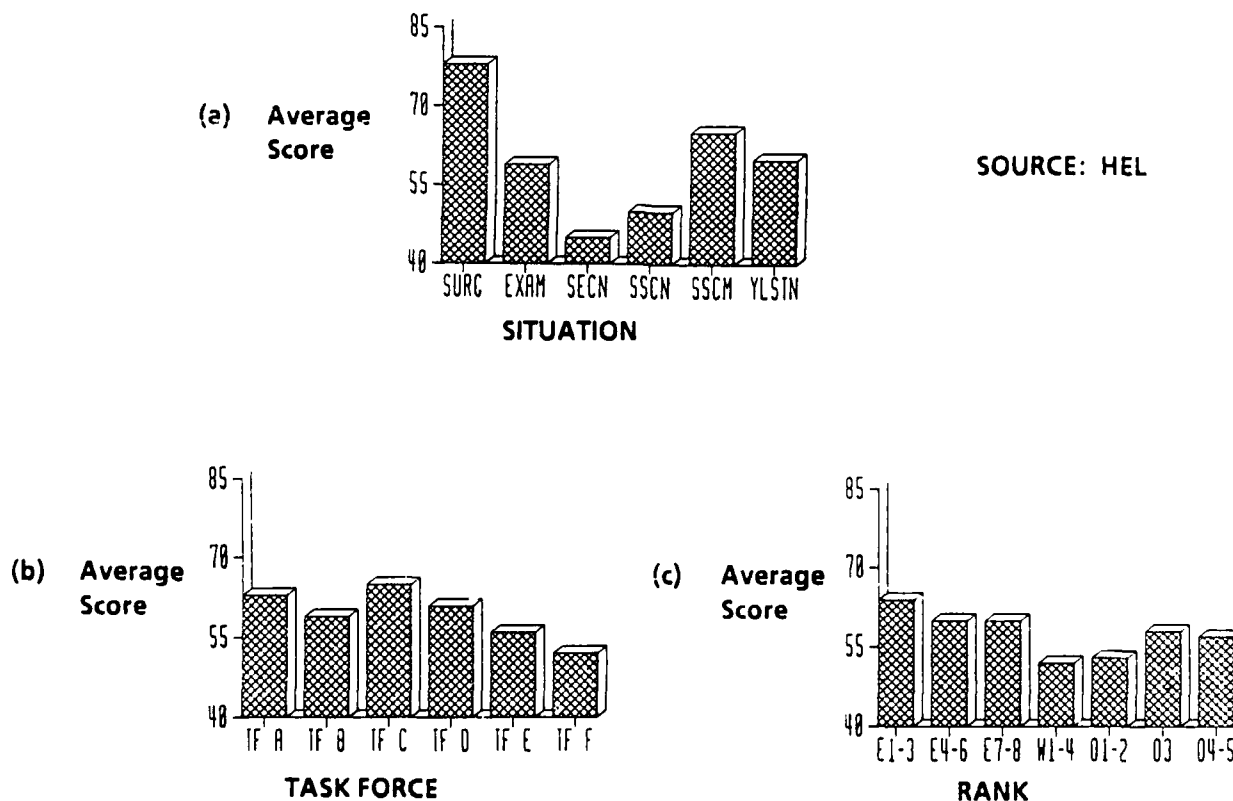


Figure I-4. Anxiety, from the MAACL-R

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GLOSSARY

ABBREVIATIONS, ACRONYMS, AND SHORT TERMS

AAR	After Action Report prepared by the Joint Task Force, Yellowstone
AMC	US Army Materiel Command
ARI	US Army Research Institute for the Behavioral Social Sciences
BIFC	Base Interagency Fire Center
CAA	US Army Concepts Analysis Agency
Combi tool	combination McLeod and Pulaski tools--it has a longer handle than the other two tools
EEA	essential element(s) of analysis
FTX	field training exercise
HEL	Human Engineering Laboratory
JTF	Department of Defense Joint Task Force, Yellowstone
LABCOM	US Army Laboratory Command
MAACL-R	Multiple Affect Adjective Check List--Revised. It is a standard psychological test
McLeod	heavy-duty rake for burning underbrush--it has a 48-inch handle
MOS	military occupational specialty
NTC	National Training Center, Fort Irwin, California
ODCSOPS	Office of the Deputy Chief of Staff for Operations and Plans
OPCON	operational control
Pulaski	an axe with a 30-inch handle
R&R	rest and recuperation
SECN	surgical/examination control group
SRL	Systems Research Laboratory, ARI

SS	Salvo Stress Study. It studied airborne soldiers firing at targets, in both a highly competitive marksmanship setting and in a noncompetitive environment
SSCM	Salvo Stress Study competitive group
SSCN	Salvo Stress Study control group
stressor	a factor that causes physical or psychological stress in a human being. A limited amount of stress is needed for motivation. After extremely high levels of stress, or even high levels of stress for a sustained period, an individual will collapse from exhaustion
TF	task force
TOC	Tactical Operations Center
USFS	US Forest Service
WRAIR	Walter Reed Army Institute for Research



**FIRE FIGHTING TASK FORCE
(FIRE)**

**STUDY
SUMMARY
CAA-SR-89-10**

THE REASON FOR PERFORMING THE STUDY was to determine whether forest fire fighting causes combat-like stress, and if so, determine the factors that cause the stress. In other words, find out whether studying forest fires adds to our knowledge of combat effects on the soldier and soldier performance in combat. Assuming that forest fire fighting is somewhat similar to combat, results will be useful in developing algorithms and data for use in US Army Concepts Analysis Agency (CAA) combat models.

THE STUDY SPONSOR was the Director, US Army Concepts Analysis Agency.

THE STUDY OBJECTIVES were to:

- (1) Collect and analyze data on the fatigue and stress of forest fire fighting.
- (2) Determine the major factors that cause fatigue or stress when fighting forest fires.
- (3) Decide whether the effects of forest fire fighting are similar to the effects of actual combat.
- (4) Develop estimates of soldiers' performance during combat and assure that they are in a form that can be used as data in combat models.
- (5) Build an information base for building a more complete field study which measures the factors that cause forest fire fighting stress and the differences in soldier performance which are caused by those stresses.

THE SCOPE OF THE STUDY is limited to analysis of data collected from Army soldiers who fought forest fires in and around Yellowstone National Park. Civilian fire fighters are not included because we have no baseline measurements and would not be able to obtain them. Marines are not included; they arrived after most of the fires had been contained.

THE MAIN ASSUMPTION is that soldier reaction to stress caused by forest fire fighting, as measured by their performance on assigned duties, will be similar to their reactions from the same stressor caused by actual combat.

THE BASIC APPROACH was to quickly form a multidisciplinary, multiagency team of human performance and stress measurements experts, collect as much data from the soldiers who fought the fires as possible in the limited time available using both questionnaires and interviews, then obtain the unit's After Action Report (which provided additional detail). The research agencies individually analyzed the data they collected; CAA integrated the results.

THE PRINCIPAL FINDING OF THE STUDY is forest fire fighting causes higher stress levels than the Army has measured in laboratory settings and is therefore combat-like. However, we believe that the stress is less than combat stress. The number of days that the soldiers actually faced blazing fires seemed to be 13 or fewer during approximately 4 weeks at Yellowstone. We identified a variety of stressors at Yellowstone. They range from traditional combat stressors (such as fatigue, terrain, and fear), to Yellowstone unique stressors (working with civilians), to stressors that were stressors at Yellowstone, will probably be stressors in combat, and are not usually studied as stressors because Army field exercises are expected to condition the soldiers to them--austere living conditions and hostile environment. Since they seemed to be stressors at Yellowstone, we believe the latter should be expected stressors in combat.

THE KEY OBSERVATION is that officer responses were very different from enlisted responses. The enlisted soldiers rated the Yellowstone experience as more stressful and as more life-threatening. They felt their coping efficacy was lower. They were more depressed, more hostile, more anxious, and had fewer good feelings about themselves. Their duties were more physically difficult and probably more life-threatening. It is important to know whether there is something unique about fighting forest fires, or whether these differences should be expected in most operations, particularly combat. Since knowing the psychological changes that result from combat or combat-like operations may help in developing techniques that will avoid the high rates of neuropsychiatric breakdowns expected during intense combat, we believe these results have important implications.

THE STUDY EFFORT was directed by Ms. Sally J. Van Nostrand, Force Systems Directorate. Other Army agencies participated in the study--US Army Research Institute for the Behavioral and Social Sciences, US Laboratory Command Human Engineering Laboratory, and Walter Reed Institute for Research.

COMMENTS AND QUESTIONS may be sent to the Director, US Army Concepts Analysis Agency, ATTN: CSCA-FS, 8120 Woodmont Avenue, Bethesda, MD 20814-2797.