Research Product 80-4a

HUMAN PERFORMANCE IN CONTINUOUS OPERATIONS:

Volume I.

HUMAN PERFORMANCE GUIDELINES

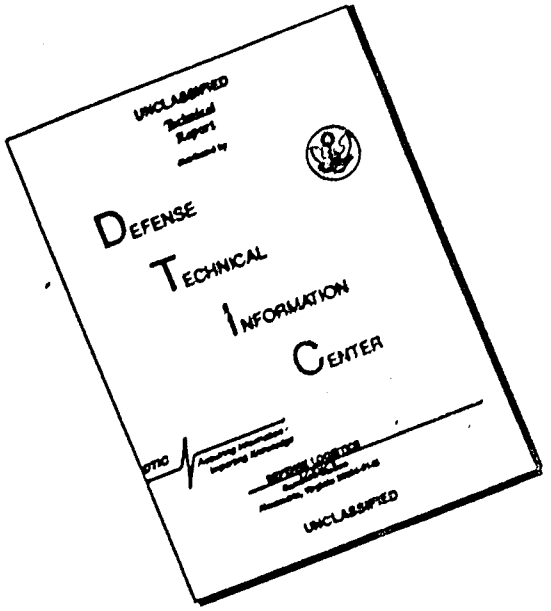
MANPOWER AND EDUCATIONAL SYSTEMS

TECHNICAL AREA

December 1979

U.S. ARMY RESEARCH INSTITUTE for the BEHAVIORAL and SOCIAL SCIENCES

DISCLAIMER NOTICE



THIS DOCUMENT IS BEST QUALITY AVAILABLE. THE COPY FURNISHED TO DTIC CONTAINED A SIGNIFICANT NUMBER OF PAGES WHICH DO NOT REPRODUCE LEGIBLY.

U. S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

A Field Operating Agency under the Jurisdiction of the Deputy Chief of Staff for Personnel

JOSEPH ZEIDNER
Technical Director

FRANKLIN A. HART
Colonel, US Army
Commander

NOTICES

DISTRIBUTION: Primary distribution of this report has been made by ARI. Please address correspondence concerning distribution of reports to: U. S. Army Research Institute for the Behavioral and Social Sciences, ATTN: PERI-TP, 5001 Eisenhower Avenue, Alexandria, Virginia 22333.

FINAL DISPOSITION: This report may be destroyed when it is no longer needed. Please do not return it to the U. S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE AD A076131	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER: Research Product 80-4a	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): Human Performance in Continuous Operations: Volume I. Human Performance Guidelines	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Arthur I. Siegel, Mark G. Pfeiffer, Felix F. Kopstein, and Lawrence G. Wilson (APS); Halim Ozkaptan (ARI)	8. CONTRACT OR GRANT NUMBER(s): DAHC19-77-C-0054
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Applied Psychological Services, Inc. Science Center Wayne, Pennsylvania 19087	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2Q163743A774
11. CONTROLLING OFFICE NAME AND ADDRESS: Combined Army Combat Development Activity Fort Leavenworth, KS 66027	12. REPORT DATE: December 1979
	13. NUMBER OF PAGES: 533
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office): U.S. Army Research Institute for the Behavioral and Social Sciences Alexandria, Virginia 22333	15. SECURITY CLASS. (of this report): UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Human Performance	Human Factors	Training Requirements
Stress Management	Performance Maximization	Training Methods
Unit Development	Performance Degradation	Battle Management
Performance Analysis	Vulnerability/Survivability	Performance Support
Continuous Operations	Work/Rest Cycles	Work Aids

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This document provides guidelines to the military commander on expected human performance degradation of continuous ground combat. Degradation projections are based on extrapolations from scientific literature and realistic scenarios of continuous operations.

The advantages and application of task restructuring, task reallocation, and work rest management concepts in the continuous operations context are presented along with considerations for training, system design, and performance support.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

40 774

20. Comprehensive tables show anticipated performance degradation for specific duty positions in the mechanized infantry, artillery, armor, and FIST categories. Methods are discussed for minimizing the anticipated degradation.

Research Product 80-4a

HUMAN PERFORMANCE IN CONTINUOUS OPERATIONS: Volume I. HUMAN PERFORMANCE GUIDELINES

Arthur I. Siegel, Mark G. Pfeiffer, Felix F. Kopstein
and Lawrence B. Wilson
Applied Psychological Services, Inc.

and

Halim Ozkaptan
Army Research Institute

MANPOWER AND EDUCATIONAL SYSTEMS TECHNICAL AREA

U.S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES
5001 Eisenhower Avenue, Alexandria, Virginia 22333

Office, Deputy Chief of Staff for Personnel
Department of the Army

December 1979

FOREWORD

Night and continuous operations place new and unique demands on operating personnel. Effective doctrine and tactics cannot be formulated unless human capabilities and limitations in this environment are understood and accomodated through equipment aids, new operating procedures, and special training, as well as revised manning and rotation cycles.

The most recent product of research on Human Performance in Continuous Operations consists of three volumes. This document, Volume I, presents Guidelines to the military user on expected human performance capabilities during continuous combat. Volume II provides a Management Guide on how to minimize expected performance decrements during continuous operations. Volume III, Technical Supplement, depicts the technical aspects of the development and background data for the information contained in Volumes I and II, and describes the methods employed for predicting performance degradation. Together they update and replace ARI Research Product 79-8, "Human Performance in Continuous Operations Guidelines," and Technical Report 386, which provided background data. The three volumes provide a body of general and highly specific information about the soldier's tasks on which degraded performance can be anticipated during continuous operations. Such information will be useful to tactical planners, training specialists, and design engineers.

The research was conducted under Contract DAHC 19-77-C-0054, as part of Army Project 2Q163743A774, Man-Machine Interface in Integrated Battlefield Control Systems, FY 1978 Work Program. The research was supported by CACDA/CATRADA at Fort Leavenworth, Kansas, which was the TRADOC sponsor. Special thanks are due to Colonel Robert N. Morrison, Major Michael G. Jones, and Major Robert O. Livingston for their recommendations and cooperation.

Joseph Zeidner

JOSEPH ZEIDNER
Technical Director

PREFACE

This volume presents a compendium of data and projections of human performance degradation to be expected in the course of continuous ground combat operations. Data were derived from various sources in the scientific literature, and projections were guided by the reference framework of realistic scenarios which reflect the continuous operations concept.

The continuous operations concept has been variously defined. Regardless of definition, the concept implies combat operations at about the same level of high intensity throughout the 24 hour day over extended periods. Accordingly, the soldier will be required relentlessly to carry out the functions of combat through day and night, in any weather, and with no slackening of pace. In this context, the human element will be a dominant factor in the success equation; the consequences of progressive attrition in human performance capability may be more serious even than scope of sustained casualties and losses of equipment.

The present volume, along with a set of companion volumes, is intended to furnish guidance to military planners and formulators of doctrine for continuous operations. Each volume in the set complements the others. Each provides a separate substrate of considerations which will be valuable in achieving and maintaining readiness for continuous operations and in successfully carrying out continuous operations during combat.

A second volume, Human Resources Management Guide - Human Performance in Continuous Operations, delineates the human resources management issues in anticipation of and during continuous operations. It also outlines the management actions designed to maximize human resources and to conserve them thereafter.

A third volume, Background Data for Human Performance in Continuous Operations, summarizes the data and findings of the scientific literature on which both of the other two volumes are based. Its content and format are primarily oriented toward the technical/scientific reader rather than the military operational one.

These Guidelines are intended as a handbook for military planners and managers. The first chapter presents an elementary introduction to human factors in continuous operations and the combat scenarios which serve as the framework for subsequent data. Chapter II presents the scenario from which critical tasks are derived and against which subsequent human performance forecasts are made. Several subsequent chapters present human performance projections for critical tasks. The projections are made for up to 120 hours (five days) of continuous, unrelieved combat. Mechanized infantry, armor, fire support team, and artillery units are successively considered. A set of

final chapters presents data and information for various approaches to counteracting human performance degradation: restructuring of responsibilities, training operations, system design and performance supports, and work-rest-sleep management. Chapters may be consulted individually or the text can be read as a whole.

One of the frustrations experienced in predicting human performance under the stress of real-life situations is that man is highly adaptable and seemingly capable of enduring unusual degrees of stress and fatigue when necessary. When a soldier is driven by the motivation to survive, by exemplary leadership, or by commitment to value, predictions from laboratory data often fail. Man has exceptional resources of energy and ability in reserve for the crises of life. The cost at which such sustained performance is maintained is not yet properly understood, and therefore, difficult to predict. These difficulties have been accepted as a challenge.

In a sense, these Guidelines represent a degraded mode analysis for the soldier. A human performance reliability of unity cannot be assumed for the soldier under all conditions. And, it is the performance reliability of the soldier and of his equipment, in combination, which determines the reliability of the man-equipment system. To this end, the Guidelines present those tasks which various soldiers must perform, an indication of the anticipated performance effects of various impacting factors, nomographs for calculating performance decrement, methods for correcting various shortfalls, and a cross reference index for easy access.

We can think of no better criterion against which to judge this volume than a quote from a review* specifying the desirable characteristics of a handbook:

> "A handbook should be not a random collection of articles but a mosaic depicting the domain, central concerns, and contributions of its field. It should consolidate methods, theory, and data that are scattered over a vast primary literature. It should instruct neophytes and increase the sophistication of practitioners . . . Ideally, it should also inspire and focus the attention of the leaders in the field from whom future advances must come."

*Ross, L., & Cronbach, L. J. Review of Handbook of Evaluation Research by Marcia Guttentag & Elmer L. Struening. Educational Researcher, 1976, 5, 9-19.

Quite obviously, the development of a comprehensive handbook has depended on the contributions of a number of persons. The work of Dr. Donald P. Woodward, Office of Naval Research, and Captain Paul D. Nelson, Naval Medical Research and Development Command, was adapted and relied on heavily in developing the concluding chapter of this volume. We express our indebtedness to Major M. Jones, Major R. Livingston, and Colonel R. N. Morrison, CACDA/CATRADA for their perceptive comments and early recognition of human resources issues arising out of continuous operations in future warfare.

Arthur I. Siegel
Mark G. Pfeiffer
Felix F. Kopstein
Lawrence B. Wilson

APPLIED PSYCHOLOGICAL SERVICES, INC.
December 1979

Rules of Thumb

for

Counteracting Human Performance Deterioration

Attendant on Continuous Operations

The capability to perform a host of critical combat tasks degrades to inadequacy due to the depression of requisite critical abilities by adverse factors engendered by continuous operations. Counter measures must address themselves to enhancing and supporting these abilities. For this reason the rules of thumb listed below are categorized by critical abilites.

COMMUNICATION

- Establish a feasible maximum of SOPs together with a brief code designation for each.
- As much as possible communicate only codes representing preestablished SOPs.
- Through anticipations or questions, prompt the attempts of exhausted persons to formulate a message.
- For maximum likelihood of comprehension in the presence of noise, establish and use the smallest feasible standard vocabulary.
- Also, repeat critical words and, if feasible, provide a context for better intelligibility.
- As much as possible, duplicate/augment critical message elements in alternate communications channels (e.g., *verbal and visual*).
- Establish standard message formats (e.g., order of message elements) for standard purposes (e.g., target descriptions, relocation directions).

DYNAMIC PRECISION

- Provide a great deal of practice in aiming/firing tasks at night and from unstable platforms.
- Enhance visual cues (e.g., aiming stakes) and provide alternate ones (tactual, auditory) to guide performance.
- Provide extensive practice in aiming/firing while simultaneously maintaining body balance (e.g., narrow ledge).
- Provide extensive practice in aiming/firing with restricted "elbow room."
- Provide extensive practice in tasks requiring prolonged tracking of fast moving targets.

HEARING

- As much as possible ensure mutual visibility of speaker and listener.
- When listening for faint sounds, take account of sound impeding objects in the environment (bushes, trees, etc.) and maintain a clear soundpath in expected directions.

MEMORY

- Extensively practice recall of standard items (SOPs, nomenclatures, codes, etc.).
- Retain, at all times, provisions for recording information to be retained only for a short time (e.g., note pad).
- Develop coding schemes which makes sense to the user.
- Use redundancy to increase memory.
- Memory loss that occurs as a function of time may be reduced through overtraining.
- A standard operating procedure of solutions may be employed to lessen need for memory of details.
- As a technique to improve immediate memory the chunking or grouping of items may be employed.

NUMERICAL FACILITY

- As much as possible do not rely on "mental arithmetic," but externalize steps (e.g., on paper) of calculational process.
- Arrange for double check on numerical results through repetition or by others.
- Similarly, guard against digit reversals or transpositions in numerically encoded information.
- As much as possible reduce numerical operations to the simplest level, e.g., counting rather than adding, adding rather than multiplying, etc.

ORIENTATION

- Extensively practice use of sun, moon, and stars as directional indicators.
- Select most prominent landmarks that will be visible under virtually any conditions (night, fog) and relate to maps, charts, or terrain sketches.
- Extensively practice standard procedures for regaining orientation.
- Whenever feasible, double check orientation with that independently established by another.
- During movement: practice progress evaluation, e.g., by counting steps, and assessment of angular shifts, e.g., using clock face imagery.
- Identify, in advance, personnel who possess a high level of orientation ability. Individual differences in this ability are great.

PERCEPTUAL SPEED

- Brief personnel in advance on expected targets and their expected patterns or distribution.

REASONING

- Develop and practice standard schemes for evaluating common types of situations or problems.
- Prepare and use decision aids for standard types of problems (nomographs, tables, or, when practical, computer programs).
- Rely on parallel, but independent reasoning (two persons) in reaching decisions; compare results and evaluate discrepancies.
- Provide maximum rest for decision makers.

VISION

- Rotate target detection vigilance tasks among two or more people in brief (e.g., five minute) intervals.
- Take account of moon's (or other light source's) position in night time target detection vantage points, i.e., strive for maximum contrast of the enemy.

- Preestablish expected visual characteristics of targets to be detected.
- Extensively practice systematic scanning of terrain; at night constantly shift slightly left and right from line of scan.
- Avert flash blindness through monocular vision and rapid averting of eyes from flash direction.

GENERAL

- Use mild exercise to increase the arousal level of fatigued, but temporarily physically inactive personnel.
- When personnel, are degraded, make assignments in parallel duplicate performance.
- As an alternate to parallel assignments, practice task sharing.
- When preparing for continuous operations, assure that personnel are overtrained and cross trained.
- Practice critical tasks under degraded visibility conditions and practice first those tasks which are most vulnerable to the performance degradation resulting from continuous operations.
- Use performance supports for critical tasks.
- Provide rest whenever possible.
- Major performance decrement can be anticipated after 18 hours of continuous operation; there is considerable across task variability in anticipated performance decrement.
- Tasks which are most vulnerable to performance decrement are characterized by work pacing, time sharing, high work load, continuous attention, lack of feedback, and problem solving/decision making requirements.
- Recovery of performance after sleep loss of 48 hours will require 12 hours of sleep.

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

TABLE OF CONTENTS (Cont.)

LIST OF TABLES

LIST OF TABLES (cont.)

LIST OF TABLES (cont.)

LIST OF FIGURES

LIST OF FIGURES (Cont.)

LIST OF FIGURES (Cont.)

LIST OF FIGURES (Cont.)

LIST OF FIGURES (Cont.)

CHAPTER I

INTRODUCTION

This chapter introduces the continuous operations concept and the attendant degradation of human performance capability. Critical abilities and factors acting to depress them are outlined. Critical tasks in an active defense setting for mechanized infantry, armor, FIST, and artillery are listed.

These Guidelines are concerned with human performance in continuous operations. Its goal is to present concepts and data, in a meaningful and useful way, which depict the human performance considerations involved in implementing the continuous operations concept.

The continuous operations concept is not new nor is the conduct of operations at night or over a long period yet fully realized. Yet, in continuous operations, human capability will be degraded to a level below that which is usually found in the human factor of the total mission success equation. The question, then, is one of the degree to which this capability will be degraded during continuous operations and, further, to what degree can this lost capability be enhanced during continuous operations?

In order to answer these questions, it is necessary to know the constraints that prevent attainment of mission goals. Some of the constraints are imposed by equipment. For example, some equipment requires frequent preventive maintenance. But, the overwhelming majority of constraints are concerned with the soldier himself. His ability to perform the tasks necessary to achieve mission goals may be severely limited. For example, his performance depends on acquiring information, processing it, and responding to it in ways that are adversely affected by conditions associated with continuous operations. The human information acquisition system is anatomically designed to rely on vision as the primary source of information about the environment. But, vision relies on certain minimum levels of reflected light. Such light is not available at night.

Some of these limitations have been identified and dealt with in part by equipment advances. For example, the problem of vision at night has been partially dealt with by the introduction over the years of increasingly more sophisticated aids to vision (or by information acquisition devices which replace the information usually obtained by vision). The devices have ranged from pyrotechnic devices for providing near daylight illumination to vision substitution devices such as radar.

Although a few attempts at correcting the adverse effects of continuous operations on human performance have been made, two major problems have prevented more rapid advances. One is the lack of existing knowledge of the exact effects of the adverse conditions associated with continuous operations. The other is the lack of a consolidated and organized source of the knowledge that exists about these effects. The current effort addresses both lacks.

The decision to organize the knowledge concerning the effects of conditions associated with continuous operations on human performance of the tasks required in those operations was, in great part, the result of recent changes in Soviet military thinking. The Soviets apparently have made advances in developing the training, equipment, and tactics for continuous operations.

According to one student of Soviet strategic thinking:

> "Continuous land combat is an advanced concept of modern warfare that is made possible by the complete mechanization of land combat forces and by the technology that enables effective movement and combat at night, in poor weather, and under low visibility conditions. Armies now have the potential to fight without let-up despite those reasons that have traditionally forced a pause--darkness, fatigue, resupply, restoration, and regrouping. The Soviets have recognized continuous combat as the main principle of their combat doctrine and have been working toward that capability since 1954."

The Soviet concept is to echelon forces so that the intensity of the combat offensive can be maintained at the points of contact.

From the human factors point of view, soldiers who fight in the continuous operations situation will need to cope with the multitude of stressors associated with any battle compounded by the specific stresses of continuous operations.

These Guidelines, then, represent an intermediate end product of work to relate what is known about the effects of conditions associated with continuous operations on the performance of the soldier. It primarily is a description of problems. But, an attempt is made to formulate prescriptions for resolving some of the adverse effects of those conditions. The Guidelines may be updated as new information is accumulated and as new scenarios are developed. The Guidelines can be used as a reference source by military strategists, organizational planners, field commanders, and training program planners.

The kinds of human performance that are encompassed by continuous operations cover the entire range of human behavior. It would be quite impossible to present the results of nearly 100 years of research in one set of Guidelines. But there are, fortunately, certain economizing factors. These Guidelines have economized by concentrating on: (1) specific missions and units, (2) those conditions that are unique to human factors in continuous operations (as opposed to brief combat under ideal conditions), (3) the events found in a representative scenario, and (4) only those human tasks judged to be critical to successful mission accomplishment.

Given that not all missions and all units could be dealt with from the onset, the determination of which units and missions to consider was made on the basis of a situation which seemed to deserve primary emphasis. In light of evidence that the most likely initial encounter would be an active defense against a deliberate breakthrough attack by enemy tanks and motorized rifle divisions in a mid European environment, that site and situation was selected for attention. Because much of the backbone of such a defense will depend on combined arms teams of tank/TOW/mechanized infantry with FIST and artillery support, they were chosen as the units to be initially considered.

Unique Continuous Operations Conditions

The Guidelines are intended to consider only those conditions which are unique to continuous operations. What is there about fighting at night and/or fighting for prolonged periods of time that differentiates such combat from the more typical combat and which affects a soldier's ability to perform his job? The following factors are considered to belong to that list and are the factors whose effects are evaluated in the Guidelines:

> Light Level--at night, the amount of light present to serve as the medium for visual information is reduced to levels which drastically alter man's capability for accessing information about his environment
>
> Diurnal Rhythms--there are certain performance capabilities that are impaired when they are required at times of day different from when they normally occur or when certain cyclic behavior is disrupted (e.g., work-rest cycles)
>
> Fatigue--the effects of fatigue are not new to combat; but fatigue becomes an increasingly more important consideration for continuous combat over prolonged periods with little or no sleep possible

Cognitive Stress--continuous battle represents a constantly changing battlefield imposing unremitting pressures and a situation in which nighttime or lulls in the battle for purposes of evaluating the situation and planning missions will not be available

Other Visibility Factors--technological advances developed to correct deficiencies introduced by the preceding factors, such as night vision devices, contribute new problems, such as the susceptibility of night vision scope users to flash blindness.

Relevant Human Abilities

The execution of any task is strongly influenced by relevant abilities that are necessary for its performance. Adverse factors which operate so as to depress requisite abilities thereby produce degraded task performance. The adverse factors inherent in continuous combat operations inevitably depress critical fighting abilities and progressively degrade soldiers' combat performance. Any doctrine of continuous combat operations must come to grips with the problem of minimizing these adverse effects on human performance.

What are the abilities critical to the performance of critical combat tasks? To answer this question, a taxonomy of combat relevant abilities was developed. The taxonomy included perceptual-motor, mental (cognitive), and social abilities.

The perceptual-motor abilities included in the taxonomy are:

(a) Vision--the ability to detect visually objects and relations among objects such as movement or relative distances

(b) Hearing--the ability to detect significant sounds amid competing sounds

(c) Strength--the ability to move heavy objects using the body and limbs

(d) Impulsion--the ability to react quickly to light and sound by making rapid movements such as running, and jumping

(e) Motor Speed--the ability to maintain a high personal tempo and perform accurately using arms, hands, and fingers

(f) Static Precision--the ability to maintain good body balance and arm steadiness while aiming

(g) Dynamic Precision--the ability to maintain body balance and make accurate aiming movements while the body is in motion.

The mental abilities included in the taxonomy are:

(h) Numerical Facility--the ability to add, subtract, multiply, and divide (including when they are part of other operations such as finding percentages or cosines)

(i) Verbal Facility--the ability to use and understand written and spoken language

(j) Memory--the ability to remember information such as words, pictures, and procedures

(k) Orientation--the ability to orient in three dimensional space

(l) Reasoning--the ability to apply rules to problems and to derive answers or decisions, or to combine units of information to form a rule or to produce a set of rules necessary to arrange things or actions in order

(m) Perceptual Speed--the ability to compare letters, numbers, objects, pictures, or patterns, present or remembered, both quickly and accurately.

The social abilities included in the taxonomy are:

(n) Social Coordination--the ability to coordinate activities with one or more members of a group or to give directions or orientation to one or more members of a group

(o) Communication--the ability to transfer required and/or relevant information in proper depth and scope at the proper time.

Representative Scenario

In order to provide a basis for pursuing the analysis which led to estimates of human performance capability under continuous operations conditions, a representative scenario was required. Such a scenario served to provide:

- coherence, that is, a unifying structure on which to build the analysis and for giving it direction and identifiable boundaries
- identification of the range of values taken on by the factors listed previously

- a narrative from which a list of tasks typically performed by the individuals in a combined arms team conducting an active defense in response to an enemy breakthrough attack could be derived

- a description of situations on which judgments could be based about the degree to which individual tasks were critical to a successful defense relative to other tasks

- a flexible narrative which depicts events which could occur under any combination of conditions within the ranges identified.

A scenario was written for mechanized infantry, armor, artillery battery, and FIST teams. Each part of the scenario* contains three narrative descriptions, in fine detail, of activities in support of the active defense at various stages within the overall scenario. The three defensive actions were chosen and written to capture the range of activities and conditions which could occur so that an analysis based on these would be as complete as possible. The three defensive (platoon) actions chosen were:

(1) repel an enemy assault from a battle position

(2) create and defend a strongpoint

(3) disengage and occupy a new battle position.

Certain events were excluded, such as the use of nuclear devices or the attrition of a platoon or squad to understrength level, in order to confine the scenario to manageable proportions. Future expanded scenarios will need to deal with such important considerations.

Tasks Lists for Mechanized Infantry, Tank Crew, Artillery Battery, and FIST

Using the scenario as the boundaries, lists of tasks performed by a mechanized infantry team, an M-60 tank crew, a FIST team and 155mm artillery battery were generated using standard job analytic techniques.

To evaluate all tasks would be prohibitive. But, the tasks of interest are those tasks whose adequate performance is essential to the active defense. In order to identify these critical tasks, criticality judgments about each task were obtained from military technical advisors. These judgments ordered the tasks in terms of their criticality with respect to the overall goals of an active defense and the specific goals of each of the three defensive actions** in which a given task was performed.

*The full scenario is presented in Chapter IV.

**These are fully described in Chapter II.

The term critical means that the task in question was judged to be highly important to the fulfillment of the overall goals of the active defense as well as to the fulfillment of the specific goals of at least one of the three platoon actions. The scale of criticality lies between 0 and 99.

A summary of the number of critical tasks identified for each position studied is presented as Table 1.1, and the criticality ratings for each task against general and specific mission goals appears as Tables 1.2, 1.3, 1.4, and 1.5.

The Performance Effectiveness Index (E)

In order to assess the implications of existing scientific literature bearing on the issue of human performance effectiveness during continuous combat operations, a scale or index of effectiveness was developed. The effectiveness in question is that which remains after the debilitating factors mentioned earlier have depressed the critical fighting abilities and, consequently, performance of the critical combat tasks.

The quantitative expression of remaining human performance capability is the index of performance effectiveness "E." This index lies between 0 (zero) and 1.00. For convenience, the decimal can be omitted. For practical purposes, the index E might be considered as a percentage (actually a proportion) of effectiveness. If this is done, one must ask: percentage of what? The percentage expressed by the value E is a relative one. An E value of 0 (zero) does not imply an absolute absence of all performance capability (e.g., a fatality), nor does an E value of 100 imply absolute perfection. Rather, the limits of 0 (zero) and 100 represent the "worst" level and the "best" level of performance respectively. The worst level would be that in which all of the debilitating factors--Fatigue, Diurnal Rhythm, Light Level, Stress--are impacting so severely on critical abilities as to virtually nullify the abilities and to degrade performance capability totally. The best level would be found when these factors are absent. Accordingly, the best level might be observed at the beginning of a field exercise, and the worst level might represent performance of a difficult task on, perhaps, the fifth night of actual continuous combat operations. Any value of E between 0 (zero) and 100 expresses the "percentage" of effectiveness that can be expected when intermediate conditions prevail and intermediate levels of performance are observed.

Utility

It is anticipated that the present work will have direct utility for:

Tactics--by knowing what the soldier can and cannot perform under various conditions, it is possible to design tactics to accommodate these performance capabilities and limitations

Training--by knowing areas of required capabilities and limitations, training requirements become evident

Selection--by knowing required capabilities, selection requirements become evident

Equipment Design--by knowing which capabilities are degraded under various conditions, areas for needed equipment, which will allow the degraded soldier to function effectively, become evident.

Accordingly, the Guidelines allow the user to answer questions such as:

- Should this attack start now or should it be delayed to allow a rest period?
- Should I increase my rate of fire?
- Can I reasonably expect my men to detect enemy movement under these conditions?
- What will be the effect of cold on my unit's performance?
- Is overtraining required on this task?
- Should training on this task be emphasized?
- What shortfalls exist in my training program?
- What specific training will yield the maximum pay off?
- Where is cross training required?
- What modifications are needed in my selection policy?
- What men should I select for this mission?
- What type of man is preferred for this activity?
- What new equipment needs exist?
- What equipment do I need for successful completion of this mission?

These Guidelines do not delineate military doctrine pertaining to human resources in continuous combat operations. They merely provide some of the substantive information necessary for the formulation of such doctrine. They are intended to serve as an information resource to formulators of doctrine. The consolidation of information, not otherwise easily accessible, will provide the formulator with a set of considerations which are important facets of many decisions. As such, the Guidelines help to provide a basis for a decision--the decision itself is left to the formulator.

Table 1.1

Number of Critical Tasks by Position/Unit

Arms Team/Position		Critical Tasks
Mechanized Infantry	(Total)	76
Platoon Leader		27
Squad Leader		17
Maneuver Team Member		15
Carrier TM LDR/Weapons Operator		17
Vehicle Driver		0
Tank Platoon	(Total)	58
Tank Platoon Leader		26
Tank Commander		15
Tank Gunner		5
Tank Loader		12
Tank Driver		0
FIST	(Total)	59
FIST Chief		29
Forward Observer		27
Fire Support NCO		2
Radio Telephone Operator		1
Artillery Battery	(Total)	48
Battery Executive Officer		6
Howitzer Section Chief		11
Gunner		17
Crew Member		14

Table 1.2

Criticality Ratings for Mechanized Infantry Tasks

VEHICLE DRIVER (DR)	Critical Task No.	General Goals	Goals of Action 1	2	3
Receive orders and plans from PL		73	86	42	57
Review terrain maps with SL		64	68	43	59
Check fuel supplies		54	83	62	62
Check vehicle use supplies (water, recovery devices, etc.)		45	84	62	70
Check APC mechanical readiness		25	83	76	76
Load APC materials		23	35	66	68
Review SOPs and special orders with SL		09	44	62	56
Mount vehicle		18	71	61	66
Start engines		16	65	48	65
Drive under visual guidance, daytime		36	85	54	61
Drive under visual guidance, formation lights		23	84	44	62
Drive with NVDs		24	85	44	66
Drive in lead position		09	82	44	64
Drive under SL intercom control		07	80	44	63
Drive under PL hand signal control		09	-	39	73
Prepare to cross water		08	-	-	-
Cross water		23	-	-	-
Secure after crossing water		33	-	-	-
Drive over rough terrain		31	59	47	73
Position bounding vehicle		25	70	69	78
Position overwatching vehicle		39	72	67	78
Locate covered area		33	68	59	73
Position vehicle in covered area		33	61	65	73
Prepare APC for dismount		30	64	70	76
Move to PL directed location		57	83	54	77
Position hull down by G/CTL directions		37	-	69	79
Position hull down visually		39	-	70	79
Button up if needed		50	80	71	81
Monitor radios		50	84	69	79
Relay info to G/CTL or SL		65	85	50	76
Assist vehicle camouflage		63	-	53	80
Monitor radio		61	87	62	76
Feed ammo to G/CTL		36	63	74	69
Relocate vehicle		58	76	72	79
Move to assembly area		40	85	65	77
Position for remount		77	-	66	77
Prepare APC for remount		52	-	66	77

Table 1.2 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Assist reloading of APC		29	-	66	58
Drive concealed to disengage		68	-	63	67
Drive visually to formation		83	33	66	67
Drive under G/CTL or SL control to formation		65	33	63	69
Check gear and vehicle for damage		69	77	55	61
Check fuel and fluid supplies		57	80	81	85
Make necessary field repairs		82	66	77	83
Report vehicle readiness to G/CTL		81	71	83	75
GUNNER/CARRIER TEAM LEADER/(G/CTL)					
Receive orders and plans from PL		47	88	68	60
Review terrain maps with SL		68	87	84	60
Check condition of organic weapon		68	88	92	63
Check ammo supply		54	92	92	82
Check condition of NVDs		55	-	87	82
Check vehicle for equipment security		47	-	73	80
Assist loading of APC		42	-	77	66
Review SOPs and special orders with SL		53	-	77	74
Mount vehicle		66	-	77	62
Observe terrain for navigational purposes		68	-	87	92
Observe terrain for enemy presence		80	88	92	88
Observe PL hand signals		74	74	71	80
Observe PL flashlight signals		74	74	70	80
Intercom communicate with SL		82	-	83	74
Observe lead vehicle		82	77	77	74
Supervise water crossing		79	-	-	-
Detect direction of enemy ATs if encountered		84	82	66	76
Assist positioning of bounding vehicle		81	82	91	76
Fire from bounding vehicle	1	87	83	91	83
Overwatch bounding vehicle	2	87	82	91	83
Fire to protect bounding vehicle	3	90	87	64	83
Locate covered area		84	-		74
Direct positioning in covered area		82	85		74
Overwatch dismount	4	84	86	63	83
Direct positioning in hull down configuration		77	-	62	83
Mount NVDs if necessary		74	-	89	74
Receive PL regrouping plans		67	71	62	82

Table 1.2 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Identify TRPs		75	83	67	84
Establish range cards		83	-	67	84
Assist in vehicle camouflage		81	-	91	75
Fire .50 cal at targets		82	87	89	85
Fire .50 cal at areas	5	85	86	89	85
Maintain fire per range cards		80	-	89	76
Use NVDs		81	-	82	85
Coordinate firing with other vehicles & dismounted elements	6	86	87	90	85
Fire stationary		79	87	91	85
Fire in motion		83	85	93	89
Maintain knowledge of the squads locations	7	88	83	92	87
Communicate with PL	8	91	83	92	86
Detect enemy movement	9	93	85	94	88
Determine need to relocate	10	89	85	90	74
Establish revised TRPs and range cards	11	92	89	90	84
Direct relocation or repositioning	12	90	90	94	80
Reposition to allow other SWs to fire as needed	13	89	87	94	80
Locate assembly area		77	-	91	83
Overwatch remount		77	-	88	84
Cover disengaging squads	14	91	91	91	84
Maintain concealed disengagement	15	89	-	91	80
Receive PL regrouping instruction		90	-	88	81
Proceed to regrouping		90	-	87	76
Fire to protect regrouping	16	89	-	89	80
Check organic weapon's condition		78	90	91	67
Make repairs to organic weapons		79	88	91	72
Check ammo supplies		82	86	90	75
Report vehicle readiness to SL	17	86	84	88	78
INFANTRY MANEUVER TEAM MEMBER (MTM)					
Receive orders and plans from PL		79	72	90	77
Check condition of weapons	18	88	87	90	77
Check ammo supplies		78	84	94	85
Check other gear as needed		78	80	84	87
Check NVDs		84	-	82	78
Load vehicle		35	-	77	80
Review SOPs and special orders with SL		60	82	82	80

Table 1.2 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Mount APC		73	82	73	83
Ride in APC		75	79	75	87
Remove web gear and securing for water crossing		67	-	-	-
Support mounted organic weapon firing		83	80	92	-
Detect targets in exposed position bounding vehicle	19	86	80	90	85
Fire weapons from bounding vehicle	20	85	83	92	85
Prepare to dismount		51	80	76	94
Execute dismounting procedure		59	-	76	94
Seek concealment		75	74	79	92
Plan fire effective positions	21	87	82	92	85
Coordinate weapon's locations	22	84	82	92	85
Carry weapons to locations		63	75	94	-
Reconnoiter subsequent positions		79	77	85	86
Mark routes between possible positions	23	86	76	86	88
Identify TRPs	24	84	78	86	85
Plan fire cover for possible relocations	25	86	83	89	88
Prepare range cards		81	-	89	83
Stake out range limits for weapons		77	-	89	81
Construct obstacles		73	-	91	82
Place obstacles		71	-	93	82
Plant mines		76	-	97	83
Camouflage		77	-	94	79
Learn routes to assembly area		79	-	82	76
Detect enemy arrival at effective distance		85	-	85	81
Fire on targets	26	89	82	94	81
Fire at areas	27	86	82	94	83
Communicate with SL via hand signals		82	68	77	81
Communicate with SL vocally		81	59	72	76
Communicate with PL by radio		81	89	91	82
Fire with NVDs	28	85	-	91	81
Feed enemy progress info to SL (or PL)		81	84	92	83
Collect gear for relocation		77	54	72	78
Cover movement to new position		86	82	77	83
Move rapidly to new positons via marked routes	29	89	80	77	88
Fire while relocating	30	88	84	80	83
Move to assembly area	31	88	-	80	86
Fire to cover move to assembly area	32	88	-	80	85
Fire from moving vehicle		88	74	81	82
Collect gear for remount		81	53	82	81

Table 1.2 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Remount rapidly		82	71	73	66
Cover other remounting members		84	66	74	81
Stow gear correctly		56	32	62	69
Support organic weapons to cover disengagement		84	-	81	73
Move to assembly area		81	-	75	82
Fire to cover movement to assembly area		89	-	75	82
Check gear for damage		71	-	64	50
Check ammo supplies		83	83	56	57
Report readiness to SL		86	81	58	70
SQUAD LEADER (SL)					
Receive orders and plans from PL		63	69	78	69
Review terrain maps with DR and G/CTL		60	68	79	72
Discuss material and weapons needs with PL		67	85	85	78
Check rosters for combat ready personnel for weapons needed by mission		52	76	81	69
Check conditions of NVDs		59	-	80	81
Supervise loading of vehicles		63	72	79	78
Inspect vehicles for equipment and organic security		48	70	80	78
Review SOPs and special orders with squads		53	70	81	81
Mount vehicle		59	69	72	83
Observe terrain for concealed movement routes		76	78	85	86
Observe terrain for enemy presence	33	87	74	88	86
Direct DR		78	82	78	86
Observe PL hand signals		68	75	66	80
Observe PL flashlight signals		70	75	66	80
Coordinate defensive squad fire		80	78	92	81
Communicate with PL as needed		82	79	79	76
Maintain proper movement configurations		83	77	78	82
Direct squad to dismount configuration		70	80	87	85
Conduct dismount		73	84	78	85
Receive sector assignments from PL		81	80	87	85
Assign positions		77	82	90	94
Establish communication network	34	87	80	82	88
Identify TRPs	35	90	82	62	92
Prepare range cards	36	90	-	89	92
Establish routes to subsequent position	37	93	82	90	92

Table 1.2 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Supervise obstacle and camouflage construction	38	85	76	90	82
Coordinate plan for assembly		87	80	79	83
Direct mounted vehicle to correct configuration		81	79	53	84
Coordinate squad firing in range		81	84	90	86
Communicate with PL on progress		71	82	80	83
Report enemy status to PL		80	72	90	83
Adjust firing as necessary	39	86	87	90	88
Coordinate squad relocation if necessary	40	85	87	91	88
Direct relocation fire	41	88	86	92	88
Make new range cards as needed	42	86	86	91	84
Direct movement to assembly area	43	88	86	91	88
Direct cover fire while moving to assembly area	44	87	83	89	91
Assign exposed fire team as needed when mounted	45	89	85	90	91
Coordinate fire needs per PL instructions while mounted	46	86	80	89	55
Direct remounting		83	72	72	83
Coordinate cover fire during remount		87	71	77	-
Direct squad movement during disengagement	47	88	68	79	88
Communicate with PL during disengagement	48	88	-	72	88
Direct proper movement to regrouping	49	87	-	72	86
Assess squad's infliction of damage on enemy		80	78	78	75
Assess squad's received damage		84	77	81	80
Report assessments to PL		65	78	84	67
PLATOON LEADER (PL)					
Receive orders and plans from company		53	62	79	72
Discuss orders and plans with platoon as needed		55	64	79	74
Discuss material and weapons needs with SLs		79	79	90	80
Discuss attachments		80	80	90	84
Conduct reconnaissance	50	88	55	92	93

Table 1.2 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Check accuracy of terrain maps	51	86	68	92	91
Check with SLs on readiness		83	55	86	86
Check with company on SOPs and special orders		82	55	86	84
Check on support fire availability	52	88	79	88	85
Mount APC		82	55	81	90
Communicate formation signals by hand to SLs		62	49	70	80
Communicate formation signals by flash-light to SLs		67	45	70	80
Identify terrain reference points		83	61	87	85
Communicate with company as required		80	79	81	85
Communicate by radio/wire to squads as necessary		78	80	91	88
Decide to engage unexpected fire or not	53	85	82	91	88
Direct mounted defense	54	84	-	91	88
Communicate with OPs	55	85	-	93	89
Request possible support fire requirements from company	56	84	83	94	89
Direct approach configuration to mission area		74	82	80	91
Process plan changes from company		72	82	84	90
Select positions for cover, concealment, observation and fire	57	86	87	95	90
Communicate positioning to SLs		74	82	94	93
Select OP sights and posts		81	-	94	94
Post OPs		09	-	-	94
Establish inter-squad communication network	58	85	83	84	92
Assign locations to SLs	59	84	83	92	92
Select subsequent positions		72	81	94	92
Establish transition routes		81	79	92	92
Establish TRPs	60	84	82	96	92
Assign fire zones and targets	61	84	83	94	94
Position squad-detached APCs		83	82	92	92
Communicate with company and/or artillery as needed	62	85	86	94	90
Establish obstacles and camouflage needs		82	80	91	89
Direct preparations of squads		78	82	93	86
Choose assembly area		74	87	82	90

Table 1.2 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Instruct squads and G/CTLs on assembly plans		75	85	77	90
Inspect for readiness		69	81	78	81
Select firing configuration for mounted defense		84	82	82	81
Direct vehicle firing locations	63	87	82	85	89
Direct vehicle movement patterns	64	84	79	91	89
Coordinate firing using visual signals		80	74	90	80
Call indirect fires according to plans		81	85	92	88
Communicate with OPs and company as necessary	65	86	88	82	92
Decide when (or if) to relocate	66	88	88	84	93
Coordinate SL reports and G/CTL reports of enemy progress		80	68	82	92
Order relocation	67	88	89	79	93
Direct relocation cover	68	90	85	79	93
Coordinate changes in TRPs etc., after relocation	69	85	86	94	89
Order move to assembly area	70	87	83	84	93
Direct protective fire for move to assembly	71	88	82	87	93
Direct squad fire zones while mounted	72	87	80	87	91
Direct squad fire requirements while mounted	73	89	79	87	91
Direct remounting		74	62	78	86
Coordinate remounting protective fire		82	75	81	85
Direct disengagement	74	84	77	87	85
Call indirect fire required for disengagement	75	91	76	88	92
Recall OPs		09	-	92	-
Coordinate regrouping	76	86	67	89	88
Assess damage inflicted on enemy		83	54	89	77
Assess condition of platoon		88	54	75	79
Report mission status to company		72	81	75	78
Prepare for next mission		90	81	73	78

Table 1.3

Criticality Ratings for Tank Tasks

TANK PLATOON LEADER (TK PL)	Critical Task No.	General Goals	Goals of Action 1	2	3
Receive plans and order from the CDR		53	72	90	72
Coordinate with other PL		53	72	86	71
Coordinate with FIST Chief		56	72	84	75
Request attachments		39	58	45	71
Issue warning order		55	72	50	75
Conduct reconnaissance		52	72	59	71
Confirm accuracy of terrain maps with ground		53	62	48	73
Coordinate with 81mm FO (Fire Planning)	1	78	72	86	75
Coordinate with ARTY FO (Fire Planning)	2	78	72	86	75
Select firing positions for tanks	3	82	86	86	75
Select observation posts	4	78	84	67	71
Select routes	5	66	80	44	76
Select alternate positions	6	82	86	84	75
Select supplementary positions	7	82	86	84	75
Check with TK CDRs to determine unit readiness		46	62	45	77
Order PLT forward		44	78	25	77
Direct tactical movement of PLT enroute		55	78	25	80
Communicate positioning of tanks to the TK CDRs	8	68	78	42	80
Use hand signals		47	80	42	64
Use flag signals		47	80	42	64
Operate intercom/radio	9	67	80	87	64
Discuss local security requirements with PLT		55	84	76	73
Discuss material and weapons requirements with TK CDRs		49	60	35	61
Order hot loop be established		52	61	73	73
Communicate obstacle and camouflage requirements to PLT		50	72	69	74
Supervise defensive preparations	10	78	76	79	73
Inspect for readiness	11	73	84	49	73
Approve TK CDRs' firing data	12	72	84	82	71
Approve FO's fire plan	13	73	84	90	73
Prepare PLT terrain sketch		47	75	71	77
Prepare PLT fire plan	14	73	82	81	73
Escort TM CDR during his inspection		49	62	66	71
Mount tank		24	50	61	55
Report enemy sightings		53	86	75	74
Acquire targets	15	75	90	88	74

Table 1.3 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Determine when to commence engagement	16	80	78	86	73
Order FO's to adjust fires	17	84	90	83	74
Control employment of coordinated PLT tank fires	18	78	90	87	73
Operate laser range finder	19	71	85	88	74
Operate CDR's cupola		58	85	75	64
Track targets using periscopes		58	85	77	64
Issue crew fire commands		64	90	87	73
Override gunner's traverse	20	72	85	79	74
Fire 50 CAL MG	21	67	90	90	74
Conduct immediate action to correct 50 CAL malfunctions		56	85	81	64
Decide when to (if) to relocate	22	70	88	81	79
Order relocation of vehicles		60	88	81	79
Control formations on the move	23	71	90	72	79
Communicate positioning to TK CDRs		57	90	69	79
Adjust indirect fires	24	87	90	90	78
Reload 50 CAL MG		59	85	77	67
Initiate radiological monitor		47	58	14	69
Troubleshoot sighting equipment		61	80	75	65
Replace sight components		51	80	33	65
Troubleshoot cupola malfunctions		43	80	71	65
Troubleshoot communications malfunctions		46	80	75	63
Troubleshoot electrical malfunctions		46	80	75	63
Encode/decode messages		53	85	30	63
Transmit situation reports to CDR		56	90	51	76
Issue fragmentary orders	25	85	95	87	76
Issue spot reports	26	75	90	79	71
Assess damage inflicted on the enemy		60	85	74	73
Assess status of TK PLT		63	90	76	79
Request resupply as needed		54	80	81	63
Request medical support as needed		51	80	35	63
Redistribute supplies		64	80	76	63
Prepare for next mission		58	75	66	63
Decontaminate self		42	77	54	77
Identify chemical agents		52	85	44	74
Escape from burning tank		24	37	10	75
Escape from overturned tank		24	10	10	75
Escape from sinking tank		24	10	10	75

Table 1.3 (Cont.)

TANK COMMANDER (TK CDR)	Critical Task No.	General Goals	Goals of Action 1	2	3
Receive plans and orders from TK PL		53	72	90	72
Coordinate other TK CDRs		53	72	85	71
Coordinate with gunner	27	79	90	88	74
Coordinate with driver	28	67	81	71	80
Cordinate with loader		51	90	88	73
Inspect tank engine		45	70	47	69
Inspect tank suspension and track		45	70	47	69
Inspect tank sighting and fire control		52	80	50	67
Conduct communications check		50	80	61	63
Inspect armament/ammunition		62	80	69	64
Control tank enroute		43	85	61	73
Interpret positioning instruction of TK PL		47	90	70	70
Occupy firing position	29	65	88	87	59
Implement local security instructions		52	80	62	70
Implement barrier and camouflage instructions		56	80	68	69
Direct clearing of fields of fire		59	85	72	71
Prepare tank range card		59	83	83	70
Select targets for main gun		55	90	81	74
Select targets for 50 CAL		56	90	82	74
Select targets for COAX MG		56	90	82	74
Plan fire control measures	30	86	90	85	71
Escort PL or TM CDR during inspection	31	70	73	75	76
Mount tank		58	75	71	69
Report enemy sightings	32	74	90	81	73
Acquire targets	33	72	90	90	71
Engage targets on order	34	72	90	90	71
Adjust indirect fires	35	88	90	90	74
Operate laser range finder	36	81	85	90	74
Operate CDRs cupola		58	85	75	64
Track targets		58	85	90	64
Issue crew fire commands	37	65	90	90	73
Traverse turret with override		72	85	89	74
Fire 50 CAL MG	38	67	90	90	74
Conduct immediate action to correct		56	80	89	64
50 CAL malfunctions		56	80	89	64
Decide when to (or if) relocate	39	66	90	88	79
Order relocation of vehicle		50	90	88	79
Control driver actions when moving	40	71	90	83	79
Reload 50 CAL MG as required		59	80	84	67
Troubleshoot sighting equipment		61	80	74	65
Troubleshoot fire controls		62	80	74	65
Troubleshoot communications equipment		46	80	74	63
Troubleshoot cupola malfunction		43	80	74	65
Encode/decode messages		53	80	39	63

Table 1.3 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Transmit status reports to TK PL		55	90	56	76
Transmit spot reports to TK PL	41	75	90	75	71
Assess damage inflicted on enemy		63	80	72	73
Assess status of tank		63	90	80	73
Request resupply as needed		47	80	67	63
Request medical support as needed		51	80	34	63
Redistribute supplies		47	80	71	63
Prepare for next mission		58	75	60	63
Decontaminate self		42	79	54	77
Escape from burning tank		24	10	10	75
Escape from sinking tank		24	10	10	75
Escape from overturned tank		24	10	10	75
TANK GUNNER (TK GR)					
Assist TK DR in vehicle maintenance		45	50	42	79
Boresight COAX MG		50	80	49	73
Boresight main gun		55	80	59	73
Zero COAX MG		50	80	49	73
Zero main gun		55	80	59	73
Operate tank intercom		56	82	77	77
Prepare tank range card with TK CDR		52	83	85	72
Operate ballistics computer		58	90	85	72
Operate azimuth indicator		58	90	85	72
Identify target reference points		59	79	75	70
Identify map symbols on the ground		59	65	61	76
Determine fields of fire for main gun		61	87	85	71
Determine fields of fire for COAX MG		62	87	85	71
Advise TK CDR of deadspace in fields of fire		57	78	76	73
Acquire targets	42	84	88	89	74
Track targets	43	84	88	89	74
Receive fire commands from TK CDR	44	82	81	89	73
Fire main gun	45	82	90	89	73
Fire COAX MG	46	81	90	89	73
Diagnose turret/maingun/traverse malfunctions		57	75	78	74
Diagnose sighting and fire control malfunctions		57	85	79	74
Diagnose recoil malfunctions		57	85	74	74
Diagnose commo malfunctions		51	75	71	73
Measure radiation		51	49	46	74

Table 1.3 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Decontaminate self		48	49	46	77
Escape from burning tank		24	10	10	76
Escape from overturned tank		24	10	10	76
Escape from sinking tank		24	10	10	76
TANK LOADER (TK LDR)					
Assist TK DR in vehicle maintenance		45	50	42	79
Load ammunition on tank		53	85	84	73
Operate tank intercom		53	80	82	73
Load COAX MG	47	72	85	90	73
Load 50 CAL MG	48	72	85	90	73
Handle main gun rounds	49	82	90	83	74
Load selected rounds	50	82	95	90	74
Conduct WPN safety checks	51	77	90	85	74
Conduct communications operation checks	52	76	80	85	76
Set head space and timing on 50.	53	72	66	77	74
Inventory ammunition		67	70	61	73
Operate breach mechanism	54	76	90	85	74
Operate fire/safety switch	55	76	90	80	74
Advise TK GR when COAX and main gun can fire	56	77	90	85	73
Conduct immediate action to correct COAX malfunction	57	72	85	72	74
Unload unoperational main gun rounds	58	71	85	72	74
Dispose of expended round cannisters		22	60	50	69
Advise TK CDR of ammo status		59	80	80	76
Assist TK CDR with observation		52	45	66	68
Camouflage tank		38	54	45	69
Dismount tank for local security		60	49	47	73
Install/remove field phones		52	58	51	64
Install/remove wire		52	58	51	64
Erect obstacles		59	67	67	65
Diagnose breach malfunctions		57	71	79	64
Implace/recover mines		64	68	67	65
Measure radiation		51	41	46	74
Decontaminate self		48	41	46	77
Escape from burning tank		24	10	10	76
Escape from overturned tank		24	10	10	76
Escape from sinking tank		24	10	10	76

Table 1.3 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
TANK DRIVER (TK DR)					
Inspect tank engine		45	80	31	79
Inspect tank track		45	80	31	79
Assist crew in maintenance		45	50	31	79
Install/remove engine		45	50	31	79
Install/remove track		45	50	31	79
Drive tank on level terrain		53	64	69	80
Drive tank on steep grades		53	64	69	80
Drive tank during periods of darkness or limited visibility		61	66	74	80
Drive tank on slide slopes		53	64	69	80
Drive tank over water obstacles		53	66	59	80
Camouflage vehicle		38	72	45	77
Drive tank in mud/snow/sand/ice		53	66	74	80
Drive tank in convoy		53	20	17	70
Install periscopes		50	76	23	70
Install IR periscope		50	77	23	70
Conduct before/during/after operations checks		49	90	71	79
Prepare tank for normal operations		49	77	77	79
Prepare tank for water operations		50	77	77	79
Prepare tank for cold weather operations		49	77	77	79
Prepare tank for hot weather operations		49	77	77	79
Operate intercom		50	79	71	74
Refuel tank		52	65	33	74
Dismount tank for local security		55	79	67	65
Erect obstacles		59	77	67	63
Implace/recover mines		64	76	67	63
Measure radiation		51	68	46	74
Decontaminate self		47	49	46	77
Decontaminate tank		42	49	46	79
Escape from burning tank		24	10	10	76
Escape from sinking tank		24	10	10	76
Escape from overturned tank		24	10	10	76
Prepare tank for recovery		48	75	44	79

Table 1.4

Criticality Ratings for FIST Tasks

FIST CHIEF	Critical Task No.	General Goals	Goals of Action 1	2	3
Receive orders and plans from TM CDR	1	65	70	14	69
Coordinate with TM CDR	2	65	69	22	70
Coordinate with PLs	3	64	69	40	62
Coordinate with FSO	4	61	69	33	28
Coordinate with 4.2" FO		47	63	22	53
Coordinate with ARTY FO TMS		53	69	86	62
Coordinate with FS NCO		54	63	87	84
Coordinate with 4.2" FDC		56	63	44	47
Coordinate with 81mm FDC		56	44	44	34
Coordinate with DS BAT FDC		56	69	92	49
Conduct observation post reconnaissance		57	71	56	81
Conduct route reconnaissance		37	51	48	79
Confirm accuracy of terrain maps		37	25	44	68
Identify key TRPs		49	29	45	67
Select OPs	5	59	66	87	93
Identify targets		54	68	83	76
Transmit target intelligence		55	51	71	62
Establish TRPs		56	59	69	67
Establish FPFs		58	72	60	83
Establish TGPs		57	71	67	76
Plan WPN SYS, round, FUZE, MOE, & MOC for each target	6	61	66	74	56
Use field binoculars		58	66	84	74
Operate NOD		58	66	84	74
Operate laser locator-designator	7	60	66	86	73
Operate digital message device		58	66	75	72
Use compass		54	48	60	56
Operate radio		54	55	79	61
Operate field telephone		57	68	72	9
Establish communications with the supported CDR (wire & radio)		56	62	77	14
Establish communications with the ARTY FOs (wire & radio)		51	69	79	26
Establish communications with the ARTY FDC (wire & radio)		51	69	79	26
Use CEOI (book)		29	29	24	11
Orient for direction	8	64	90	76	73

Table 1.4 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Determine exact position on the ground	9	59	90	76	85
Prepare a terrain sketch		54	64	75	81
Prepare initial target list		54	64	71	90
Prepare initial target overlay		54	64	72	90
Transmit target list to FSO		55	19	33	70
Encode target information using KAL61		66	19	27	60
Transmit hasty target lists using gridded thrust line		57	19	27	70
Make use of CEOI extract of the gridded template coding table		56	19	27	40
Acquire targets		55	81	82	82
Determine target range		45	81	85	82
Make appropriate call for fire (grid, polar, shift, etc.)		56	79	92	82
Observe effects of fire		58	79	81	85
Correct for range		56	81	73	78
Correct for deviation		56	79	69	78
Adjust corrective fires	10	59	81	73	81
Engage targets of opportunity	11	59	85	69	81
Adjust CLGP (laser)	12	62	86	70	80
Adjust smoke missions		56	79	43	85
Adjust open sheaf missions		57	77	43	73
Adjust converging sheaf mission		54	62	69	60
Adjust irregularly shaped target		54	73	71	60
Determine when to request a fire for effect		58	80	77	67
Determine when to request end of mission	13	67	80	77	67
Adjust registration mission		56	34	21	5
Adjust ICM mission	14	64	82	70	76
Adjust counterfire mission	15	63	84	45	70
Advise CDR in use of direct fire WPNS to suppress EN		56	77	64	75
Adjust immediate suppression	16	59	75	64	75
Monitor FO CFF		59	47	33	64
Approve FO CFF	17	67	53	54	72
Redirect FO CFF	18	62	68	84	83
Request FSO provide GS artillery support	19	66	79	84	83
Adjust TACAIR	20	65	86	84	81
Adjust high burst	21	67	71	50	66
Adjust attack helicopters	22	65	86	84	81
Adjust naval gun fire		64	86	84	81
Adjust mortars	23	62	62	61	81
Mount APC		54	10	42	58
Adjust illumination	24	62	55	75	52

Table 1.4 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Adjust danger close	25	60	81	69	82
Adjust fire by sound		54	68	58	64
Adjust multiple missions	26	65	82	71	79
Direct actions of FS NCO		57	52	74	79
Direct actions of RTO		54	26	46	74
Direct actions of driver		57	18	19	68
Report target engagement results	27	63	78	46	28
Order relocation of FIST	28	60	85	67	93
Relay calls for fire	29	67	81	79	80
Talk inexperienced observer through CFF		58	81	79	80
FORWARD OBSERVER (FO)					
Receive plans and orders from FIST Chief	30	66	77	57	72
Receive plans and orders from PL	31	65	81	92	84
Coordinate with FIST Chief	32	62	72	43	52
Coordinate with PL	33	65	81	78	81
Coordinate with RTO		54	40	46	51
Coordinate with FDC	34	61	69	46	49
Conduct OP reconnaissance		57	39	60	67
Conduct route reconnaissance		37	39	39	84
Confirm accuracy of terrain maps		37	34	34	61
Identify key TRPs		49	34	35	61
Select OPs	35	59	78	85	86
Identify targets		54	65	88	73
Transmit target intelligence		53	48	71	69
Select TRPs		56	57	61	76
Establish FPs		58	72	78	89
Establish target groups		57	77	87	87
Use field binoculars		58	73	82	78
Operate NOD		58	73	82	78
Operate laser locator-designator	36	60	58	88	78
Operate digital message device		58	82	82	78
Use compass		54	58	72	68
Operate radio		54	59	82	73
Operate field telephone		57	56	77	50
Establish communications with FDC		51	73	76	68
Use CEOI		29	57	17	47
Orient for direction	37	64	90	85	82
Determine exact location on the ground	38	59	90	85	82
Prepare terrain sketch		54	64	62	82
Prepare target list		54	64	56	82
Prepare target overlay		54	64	56	82
Encode target information using KAL61		56	64	15	72
Transmit target list		55	64	26	82

Table 1.4 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Transmit hasty target list using gridded THRUSTLINE		57	64	29	82
Make use of CEOI extract on the gridded template coding TB		57	64	25	72
Acquire targets	39	59	69	92	81
Determine range of target	40	59	69	88	81
Determine direction of target	41	59	69	88	81
Place appropriate CFF (grid, polar-plot, shift, etc.)		56	85	91	81
Observe effects		58	85	81	76
Correct for range		56	92	83	81
Correct for deviation		56	87	82	79
Adjust fires		58	87	85	81
Engage targets of opportunity	42	59	87	80	89
Adjust CLGP	43	59	92	79	87
Adjust smoke missions		56	87	49	89
Adjust open sheaf missions		57	65	51	85
Adjust converging sheaf missions		54	65	79	86
Adjust irregularly shaped target missions		54	66	66	84
Determine when to request fire for effect		58	79	91	85
Determine when to request end of mission	44	67	50	73	85
Adjust registration missions		56	52	21	51
Adjust ICM missions	45	64	79	70	83
Adjust counterfire missions	46	63	57	45	87
Adjust immediate suppressive fires	47	59	74	64	87
Adjust TACAIR	48	65	85	84	87
Adjust high burst missions	49	67	71	50	71
Adjust attack helicopters	50	65	86	84	87
Adjust naval gunfire		64	86	84	87
Adjust mortars	51	62	63	61	87
Adjust illumination	52	62	55	75	51
Adjust danger close	53	60	84	69	90
Adjust fire by sound		54	68	58	63
Adjust multiple mission	54	65	85	71	81
Report target engagement results	55	63	78	46	28
Relay calls for fire	56	67	86	79	80
Talk an inexperienced observer through a call for fire		58	81	79	80

Table 1.4 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
FIRE SUPPORT NCO (FS NCO)					
Receive plans and orders from FIST Chief	57	66	67	55	90
Coordinate with FIST Chief		56	63	65	90
Supervise FIST driver		55	14	10	70
Supervise FIST RTO		57	14	39	63
Request FIST rations		30	5	5	15
Request FIST water		30	5	5	15
Request FIST fuel		30	5	5	15
Request FIST ammo		32	7	5	15
Procure FIST rations		32	5	5	15
Procure FIST water		32	5	5	15
Procure FIST fuel		32	5	5	15
Procure FIST ammo		32	7	5	15
Issue rations		31	5	5	15
Issue water		32	5	5	15
Issue ammo		32	7	5	15
Supervise maintenance activities		27	10	5	35
Supervise camouflaging activities		51	22	21	16
Monitor communications on mortar PLT fire control nets		47	69	58	71
Record target lists sent by mortar FO's to FDC		58	75	37	71
Assist FIST Chief consolidate company target list		58	75	38	71
Assist FIST Chief prepare target overlay		58	75	38	75
Coordinate with mortar PLT FDC Chief		54	76	74	61
Act as vehicle commander		38	34	26	71
Redirect FO CFFs	58	72	79	81	84
Mount vehicle		15	11	11	67
Prepare range card		47	54	14	49
Coordinate local security		48	51	18	53
Report results of mortar engagements to FIST Chief		57	69	44	63
RADIO TELEPHONE OPERATOR (RTO)					
Operate radio		52	83	82	79
Operate field telephone	59	60	77	70	64
Install remote communications device		58	76	42	50
Install secure communications device		58	77	42	48
Lay wire (WD/1)		56	76	42	49
Monitor radio communications		45	62	44	69
Monitor field telephone communications		45	62	44	63
Operate switchboard		43	58	42	54
Transmit messages		55	83	52	54

Table 1.4 (Cont.)

Critical Task No.	General Goals	Goals of Action 1	2	3
Record messages	26	28	20	44
Repeat CFFs	40	83	81	65
Be prepared to adjust fires if ordered to do so	54	87	90	87

Table 1.5

Circularity Ratings for Artillery Battery Tasks

BATTERY EXECUTIVE OFFICER (XO)	Critical Task No.	General Goals	Goals of Action 1	2	3
Serve as acting battery CO		40	82	82	88
Supervise battery when it occupies a firing position	1	80	82	89	89
Lay the battery when it occupies a firing position	2	78	90	89	89
Measure and report directions	3	68	66	66	79
Determine minimum quadrant elevation		60	66	66	79
Supervise section chiefs during boresighting		40	63	66	69
Control fires of the battery	4	83	90	90	89
Insure before, during, after DPS maintenance is performed		35	48	30	64
Insure area improvements are completed in accordance with BC's order		44	74	79	88
Insure sections store, segregate and protect ammo	5	79	58	66	71
Render XO's report to FDC		56	48	90	60
Insure intra-battery communications are established		65	77	72	62
Insure safe firing practices are observed in battery		40	29	34	35
Insure each section chief knows location of his supplementary position		62	72	84	89
Insure each section chief has reconned route to supplementary position		62	72	84	89
Coordinate with ISG to determine fire sectors for each Howitzer		60	72	85	89
Supervise section chiefs in preparing range cards		52	52	75	79
Insure ammo is distributed in accordance with anticipated needs of FDC	6	75	62	74	76
HOWITZER SECTION CHIEF (HOW SC)					
Insure his weapon is properly emplaced	7	72	84	81	80
Insure weapon is ready for action	8	72	84	83	80
Lay weapon	9	73	84	90	80
Select aiming points for gunner	10	73	70	75	67
Site to the crest	11	77	70	75	67

Table 1.5 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Order when to boresight	12	77	70	65	10
Order azimuths marked	13	77	63	78	10
Order the prefire checks performed	14	68	63	65	10
Position local security		51	61	78	83
Supervise camouflaging		44	10	40	83
Supervise construction of field fortifications		55	22	44	85
Measure and report site to the crest	15	77	43	75	61
Determine piece to crest range	16	77	43	75	61
Supervise section during firing	17	83	84	90	85
Observe and check functioning during firing		44	15	61	75
Report observed malfunctions or errors		44	15	61	75
Inspect ammo storage, segregation, and protection		50	15	5	75
Inspect maintenance performed		60	5	5	22
Insure on board ammo and gear is stored properly		53	10	5	22
Prepare range cards for all section crew-served WPNS		53	56	41	72
Control his howitzer fires during direct fire engagement		50	86	68	90
Organize section for continuous operation		56	62	70	76
Maintain firing and maintenance records		24	5	5	24
GUNNER (GR)					
Lay cannon on initial direction of fire with aiming circle	18	75	87	86	89
Lay cannon on initial direction of fire with compass	19	75	87	86	89
Lay cannon on initial direction of fire with distant aiming point	20	75	87	86	89
Lay cannon on initial direction of fire by reciprocal lay of another cannon	21	75	87	86	89
Verify direction of fire with reciprocal check as control piece	22	75	87	80	84
Verify direction of fire with reciprocal check as adjacent piece	23	75	87	80	84
Verify direction of fire with reciprocal check using lighting device	24	75	87	80	76
Align collimater/aiming posts		64	64	59	62

Table 1.5 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Boresight the panoramic telescope with the MAO alignment device	25	72	64	78	87
Boresight the panoramic telescope with a distant aiming point	26	72	64	78	87
Boresight the panoramic telescope with the collimater	27	72	64	78	87
Boresight the panoramic telescope using the testing target	28	72	64	78	87
Set/lay cannon for deflection	29	79	87	84	89
Sight on a target during direct fire with panoramic telescope		52	90	82	90
Refer the piece	30	75	64	80	71
Determine the altitude of a point using a map		30	5	6	27
Convert grid to magnetic azimuth		30	5	6	79
Convert magnetic to grid azimuth		30	5	6	79
Measure an azimuth on a map using a protractor		34	5	6	79
Measure ground distance on a map		34	5	6	79
Locate an unknown point on a map by intersection		30	5	17	79
Locate an unknown point on a map by resection		30	5	5	79
Orient a map with a compass	31	74	5	10	89
Orient a map by terrain association	32	74	5	10	89
Determine present location by terrain association	33	79	5	6	89
Select movement route using a map		48	5	11	89
Navigate from one point to another using map and compass		48	5	16	89
Locate a point on a map using the military grid-ref system	34	72	5	6	84
Lead a security patrol		41	5	20	58
CREWMEMBER (CM)					
Prepare a position to receive/emplace a cannon		65	38	87	77
Guide vehicles using arm and hand signals		56	29	87	77
Guide vehicles using flashlight signals		56	29	87	77
Engage/disengage tube travel lock		23	5	6	49
Emplace/recover spades		35	5	15	49
Lay communications wire to FDC	35	82	38	35	35
Connect wire to telepost terminal on vehicle	36	82	38	35	35
Emplace/recover collimater	37	71	29	35	18

Table 1.5 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Emplace/recover aiming posts	38	71	29	55	57
Boresight the direct fire telescope using distant aiming point		56	29	57	39
Transport cannon ammo onto the vehicle		61	29	81	2
Prepare cannon ammo for helicopter resupply		65	34	81	2
Operate material handling hoist on M 548 cargo		61	29	2	2
Store ammo at a cannon position	39	66	29	34	67
Protect the ammo		56	29	34	60
Segregate the ammo by type		56	20	34	26
Monitor and relay fire commands	40	85	85	89	94
Prepare ammo for firing	41	85	85	89	6
Recognize ammo types by color coding	42	85	65	60	4
Identify fuzes and fuze wrenches by type	43	85	65	89	9
Fuze the projectile	44	85	85	70	17
Set the fuze using the proper fuze setter	45	85	85	70	21
Prepare propellant charge	46	85	85	80	21
Set/lay cannon for quadrant with the range quadrant	47	75	65	80	79
Measure the quadrant with the range quadrant		65	65	73	70
Sight on a target with a direct fire/elbow telescope		55	75	78	82
Load a "prefixed" round		57	79	76	65
Load a "separately-loaded" round		57	79	76	65
Ram a projectile with the power rammer		57	79	67	55
Fire the cannon		57	90	89	90
Place unfired powder increments in the powder pit		23	5	5	13
Clear powder chamber		20	5	5	5
Command "check fire" when unsafe conditions exist		20	10	5	16
Clear and maintain victim's airway		20	5	5	35
Stop bleeding		20	5	5	35
Treat for shock		20	5	5	35
Decontaminate casualties		20	5	5	35
Recognize/mark CBR hazards		33	5	5	60
Mask on signal		27	5	5	60
Decontaminate self, equipment, supplies		27	5	5	78
Install and operate TA312/PT		46	45	71	5
Operate vehicle intercom		27	45	66	73
Lay and maintain wire		46	45	71	5
Measure magnetic azimuth with M2 compass		30	5	5	79
Measure ground distance by pacing		15	5	5	79
Report enemy information		61	82	78	83
Process and evacuate captured enemy		33	5	5	43
Identify personnel using challenge and password		32	5	5	33
Camouflage self, weapon, equipment		56	5	5	74

Table 1.5 (Cont.)

	Critical Task No.	General Goals	Goals of Action 1	2	3
Construct individual defensive position		45	5	87	58
Prepare range card		53	5	87	70
Cross danger areas		41	5	5	84
Use M16 rifle		48	81	76	75
Prepare to fire and engage target with LAW		49	81	76	80
Use M203 grenade launcher		49	81	76	80
Emplace/recover claymore mine		48	81	76	74
Use hand grenade		40	75	76	55
Operate M60 MG		48	81	79	79
Operate CAL 50 MG		48	82	79	79
Engage ground targets with M60 MG		48	82	79	79
Engage ground targets with CAL 50 MG		48	82	79	79
Engage aerial targets with M60 MG		48	79	79	78
Engage aerial targets with CAL 50 MG		48	79	79	78
Inspect and clean aiming posts lighting devices		22	5	5	5
Clean tube and chamber		29	5	5	5
Clean chamber evaculator, valves, muzzle brake		29	5	5	5
Operate M109A1 Howitzer under unusual conditions	48	84	92	88	86

CHAPTER II

SCENARIOS

An active defense scenario in a mid-European environment is presented. Beginning with the general situation it focuses successively on a Brigade/Task Force, a combined arms team within the Task Force, and on three types of defensive actions carried out by the various elements within the team.

This chapter describes the actions of a combined arms team defending against a breakthrough attack by numerically superior threat forces. The chapter is divided into several parts, each dealing with the actions of a separate tactical element of a combined arms team: a task force, a mechanized-infantry team, an armor platoon, a fire support team (FIST), and an artillery battery. The evaluation of human performance in each of these elements, described within the body of these Guidelines, is based on this four part scenario.

A brief description of the doctrine and principles on which the organization and use of forces described here are based prefaces scenario. Part I of the scenario itself is a description of the general situation involving a battalion task force in the active defense. The focus of the team level scenario is on the command and control measures used by the Team Commander to influence the actions of his subordinate leaders and their units in fighting the defensive battle. Because the execution of the active defense during continuous operations depends heavily on the reorganization and redeployment of company-team size units, the questions of coordination and of command and control demand consideration and examination.

Flowing from the scenario are three distinct platoon actions or missions: (1) repel an attack from a battle position, (2) create and defend a strong point, and (3) disengage and move to occupy another battle position. These three platoon actions are not all inclusive. Rather, they were selected as representative of the kinds of critical actions in which a combined arms team would be involved during the execution of the active defense. The actions are not to be thought of as sequential or in a plausible order. Rather they are samples of activity that might occur at any time and in any order.

Part II of the scenario focuses on a subordinate unit of Team ACE, i.e., mechanized infantry platoons. Each of the three platoon actions previously listed, is the basis of a separate platoon scenario.

Similiarly, Part III of the scenario describes the actions taken by the tanks in support of the company/team during each of the three distinct platoon actions. Again, this yields three tank scenarios.

Part IV is concerned with FIST and Part V is concerned with the actions of the howitzer section of a 155mm SP artillery battery. The three different situations described differ slightly from the three defensive platoon actions. The first artillery scenario describes the howitzer section firing in support of a team that is under attack (without the howitzer section actually being under attack itself). This corresponds to the maneuver element repelling an attack. In the second artillery scenario, the howitzer crews fire in support of a maneuver unit that is not currently under attack which corresponds approximately to the situation of a maneuver platoon occupying and preparing to defend a battle position prior to being attacked. Finally, the third artillery scenario describes the howitzer section firing in support of the team which is under attack while displacing to avoid the effects of counter battery fires. This corresponds to the maneuver action of disengaging and withdrawing under pressure to occupy a new battle position.

Principles of Active Defense

Since the U.S. Army elements in Europe will inevitably need to conduct massive defensive operations during any next war, proper defense against and defeat of enemy attacks will be of prime importance for the initial 48 to 72 hours of the conflict.

The scenario is based on a representative mid-European environment. Its purpose is to depict a phase of the conflict emphasizing the tank-mechanized defensive operations during a three to five day period of prolonged battle involving a wide variety of environmental conditions. Starting with the active defense against deliberate attack, the scenario examines the roles and activities of the combined arms task force, its company teams, and finally, composite platoons.

The scenario assumes that the defense will be outnumbered by a ratio of six to one during the first 48 hours of the outbreak of hostilities. The magnitude with which these first operations are conducted is expected to put extreme stress on the defenders.

Concept of the Defense

The battalion task force of the scenario is a part of a large force. But, because of the need to limit the scenario, this TF and the activities are considered to be representative of all operations. The defending TF must not only defeat the attacking enemy force, but it must also keep its own losses to a minimum. The most immediate challenges facing the defender are to:

(a) destroy the enemy

(b) wear down enemy forces prior to assuming the offense

(c) force the enemy to mass so that fire can be concentrated on him

(d) retain or deny terrain, facilities, installations, and activities, or preserve forces essential to the mission

(e) gain time for activities elsewhere.

Because we anticipate that the defending force will be outnumbered, the defense is active and makes maximum effective use of its mobility and fire power.

Defense Against Echeloned Attacks

Since the opposing force attacks in echelons, the defender attempts to defeat each echelon and to have an effective force ready to oppose each subsequent echelon. The battalion TF and its organic company teams engage the attacking force from battle positions (BPs) or strong points. When necessary, these defensive positions are moved depending on the threat within the defensive sector.

At night black lights, active NIR scopes, and night vision goggles are available to assist in moving to alternate BPs. Given an enemy capability of advancing five kph at night against the covering force, the same speed or less can be assumed for periods of limited visibility when opposed by a covering force.

In the scenario, the defending Division Commander, using all available intelligence, identifies the 1st Brigade's sector as the point of the breakthrough attack. The Commander plans to concentrate his defensive efforts in this sector. The indicated initially unfavorable ratio of six to one is presumed in this scenario to have been reduced by use of effective combined arms fire to a manageable three to one ratio by the time of this scenario. The Commander is faced with conducting a representative active defense.

Fundamentals of the Active Defense

The fundamentals of the active defense are the same at night as during the day:

(1) Slow the enemy rate of movement. Since he cannot "service" all the targets at once, the defender must slow the enemy down to increase target exposure time and allow defending gunners to "service" more targets. Conventional mines and obstacles are positioned on anticipated enemy avenues of

approach before the battle begins. However, hastily implaced obstacles (scattered mines) will be employed in accordance with the actual flow of battle.

(2) Begin attrition of the enemy well-forward. As the battle approaches the MBA, artillery fire from units within the MBA augment the fire of the returning CFA elements. Tactical air is directed against target-rich areas such as enemy second echelon forces and shifted to support lead elements when their situations become critical.

(3) Engage the enemy at the maximum effective range of direct fire weapons. The enemy is engaged at the maximum effective range of each defending weapon. The primary weapon systems that determine how the battalion commander fights the battle are tanks, antitank guided missiles, and direct support artillery.

(4) Add weapons systems. The defending battalion will add weapon systems. More artillery will be added to the defender's sector by lateral repositioning of units in adjacent sectors and by shifting fire from less threatened areas. Artillery will slow tanks by use of smoke, improved conventional munitions, guided projectiles, high explosive ammunition, and scatterable mines. Counterfire against attacking artillery will reduce the amount of suppression the enemy can direct against the defender and will increase the ability of ATGM to engage early and reengage, and will reduce the defender's vulnerability during repositioning. The cannon launched terminal homing shell will give a tank killing capability beyond the range of direct fire weapons. Attack helicopters will also increase the tank killing engagement range and reduce the "target servicing" problem. Attack helicopters will be recycles from points out of range of enemy artillery and additional ATGM forces will be moved quickly by helicopter to tank proof terrain on the flanks of threatened areas or added to the forces of a strong-point.

(5) Keep the defense flexible and elastic. The most difficult task in the active defense is to inflict maximum damage without becoming so closely engaged that the defender is fixed in position by enemy action. The effectiveness of the active defense depends on maneuvering battle positions day or night to orient on the enemy force, creating strong points only when necessary to hold vital terrain or to provide a base or pivot around which other forces can maneuver or counterattack. Companies will make rapid and often fighting moves to new battle positions. Battalion commanders may direct company teams in their entirety, or they may permit independent operations at the company level while they coordinate the interaction of tanks, infantry, artillery, engineers, and air support.

(6) Destroy weakened enemy forces. When the most advanced enemy formations have been weakened by attrition, confused by the maneuvering active defense and demoralized by losses, they will be destroyed. Defending elements will maneuver to battle positions on the flank or to the rear of the enemy forces where tank guns and missiles can attack by fire without physically closing with

the enemy force. When it becomes necessary to close with the enemy to destroy his force, counterattacks will take routes that provide cover from enemy overwatching fire and will maximize the capability of tank and ATGM fire before closing with the enemy. Companies or battalions will execute these counterattacks often.

Conduct of the Active Defense by a Battalion Task Force: General Situation

The scenario contains references to coordinates and locations which can be identified by reference to the following map: Germany, 1:25,000, C-2 (Coburg) overprinted.

U.S. Forces. The 54th Inf Div (Mech), part of the I U.S. Corps, has reached a line generally along the northern side of the highway which runs from PA350665 to PA490650. At 081000 July, the division was informed that elements of the I Corps to their east had reached the Main River and were preparing for a river crossing operation which would take place in three days. I Corps elements to the northwest of the 54th Inf Div (Mech) have met increasing opposition and have been ordered to continue the attack until on line with the 54th Inf Div (Mech). The 54th Inf Div (Mech) has been ordered to defend in its present location and to be prepared to attack on order.

Enemy. Aggressor resistance increased steadily as he was driven south toward the Main River. Elements of the Aggressor 121 Fusilier Motorized Rifle Division of the 19th Combined Arms Army have been identified opposite the 54th Inf Div (Mech). Aggressor morale is good and his forces are at 90 percent authorized strength. There are no known supply deficiencies.

Air. Both friendly and enemy forces have the capability of achieving local air superiority for limited periods of time.

Nuclear Weapons. Both friendly and enemy forces have a nuclear capability. Neither force has used this capability to date.

Weather. The weather forecast for the next four days is as follows: Rainy during the period 8-13 July with scattered cloud cover. Severe thunderstorms possible daily between 1300 and 1700. Ceiling during thunderstorms will be 500 feet. Visibility extremely limited in early morning until 0700 due to ground fog. Excellent at other times except during heavy showers. The wind is out of the northwest at five to eight knots. Temperature ranges between 55 degrees F and 75 degrees F.

Terrain. The terrain in the brigade area is characterized by rolling, forested hills with steep slopes in some areas. The forests are generally cleared of underbrush; however, the size and spacing of the trees

will pose some restrictions on vehicular movement. The soil in the lower areas is composed of clay and silt alluvium deposited by the streams. At higher elevations, black loam is prevalent while the plateaus are a mixture of clay, loam, and gravel. Man made terrain features include villages, road cuts and embankments, rock walls, and roads. All of the streams in the area are fordable. The Iz River is fordable with difficulty and will require some engineering work to facilitate crossing.

Defensive Order

At 081015 July, the 1st BDE, 54th Inf Div (Mech) receives an order to defend along the northern side of the railroad, PA408664 to PA475665, for approximately three to five days.

Task Force Organization, 1st BDE

The 1st BDE is constituted as follows:

TF 4-78 Mech heavy
TF 4-79 Mech heavy
TF 4-80 Mech heavy
TF 2-4 Armor heavy
TF - 9-50 FA (155, SP)
A Btry (-) (3-454) (V) (AD) (DS)
A/54 Engr (CBT) DS
Commex. Team 54th ASACO.

Initial Sequence of Events

The enemy attacked with one division in two echelons of two regiments each. On the West he used one tank regiment of about 100 tanks followed and overwatched by another. On the East, because of closer terrain and the rain, he attacked with one tank regiment followed by a motorized rifle regiment.

On the West, the long range fire of the HAWS and tanks from all three positions have destroyed 40 to 50 tanks of the lead regiment near Roth a Forst and the BDE CO reorients that portion of his defense.

TF 4-78 is defending the western section of the 1st BDE area and is organized and positioned as follows: TM BLUE, BP 42; TM GREEN, BP 45; and TM ACE, BP 41. The next level of the scenario will concentrate on the teams of TF 4-78 (See Figure 2.1).

Organization of TF 4-78. The following list shows the make-up of the teams in TF 4-78:

TM ACE	TM BLUE	TM GREEN	TM TANK	TM CON
A/4-78(-)	C/4-78(-)	B/2-4 Armor(-)	C/1-70th Armor(-)	1/A/54
3/C/2-4 Armor	2/C/2-4 Armor	2/C/4-78 Armor	1/A/4-78	Eng (DS)
1 AT Section	2 AT Section	1 GSR Team	1 AT Sections	
1 GSR Team				

The following notes further expand TF 4-78's situation:

(1) Since TM BLUE has the largest fields of fire and controls the most likely tank approach into the area, the team has at least three tanks plus HAWS.

(2) TM ACE has a forested area to its front and is therefore subject to a mechanized infantry attack.

(3) TM GREEN is in reserve; but if the situation warrants, it can be moved forward. Foremost, the team must be able to deliver supporting fire from its location (BP 45).

Summary of Opposing Forces

The distribution of opposing forces is as follows:

(a) U.S. Battalion Task Force

37 tanks
13 APC/MICVs
8 TOWs
12 Dragon's

(b) Enemy Breakthrough Division

325 tanks
90 infantry combat vehicles
105 ATGMs

Part I--Narrative of TF 4-78 Defense

The tank regiment on the east is stopped by the terrain and well-placed direct and indirect supporting fires. Nonetheless, the motorized rifle regiment is able to move within 750m of TM ACE.

At this point TM BLUE is ordered to overwatch the movement of TM ACE as the latter shifts its long range fire into the flank of the enemy and into the forrested area North of Steinig, PA 437663.

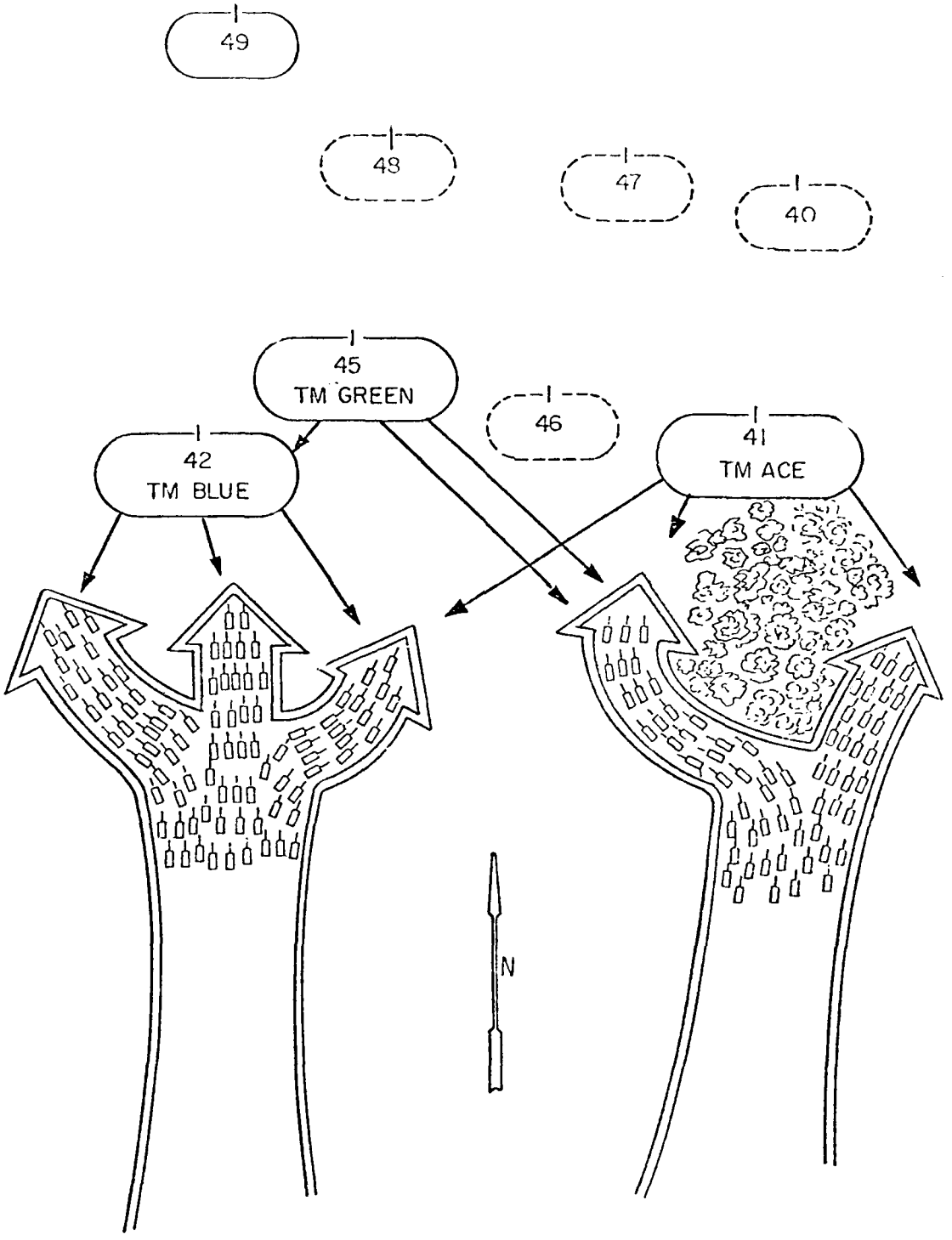


Figure 2.1. Initial BPs for [illegible]as of TF 4-78 and initial enemy approach.

TM BLUE is under very heavy artillery fire and smoke. The TF Commander:

(1) calls for artillery delivered scatterable mines north of Niederfullbach village

(2) calls for attack helicopters to engage the second tank regiment in front (north of) Niederfullbach village

(3) places heavy artillery and mortar fire in front of TM ACE

(4) asks for smoke on possible enemy antitank guided missiles at position PA 425647

(5) instructs TM GREEN to overwatch the movement of TM ACE as it shifts long range antitank fire into the flank of the enemy attack and around Niederfullbach.

At this stage of the scenario, with U.S. Forces positioned as shown in Figure 2.1, it is possible to examine more closely typical platoon actions that are critical to the active defense. "Platoon Action 1," more fully described later in this chapter, presents a description of a platoon action to repel an enemy assault from a BP.

In Figure 2.2, the threat is shown as reinforcing the advancing tank regiment with a second regiment to concentrate their breakthrough attempt. The TF Commander determines that BP 46 is crucial if the TF is to hold its position and not to allow the reinforcing threat elements to complete their attempted breakthrough. He directs that TM GREEN occupy BP 46 as a strongpoint. "Platoon Action 2," more fully described later in this chapter, presents the platoon activities involved in creating and defending a strongpoint (as part of a larger force).

TM BLUE, however, has become closely engaged and finds it necessary to fight out of its position (see Figure 2.3).

After TM GREEN moves to BP 46, the task force commander advises them to cover the movement of TM ACE to BP 40.

TM ACE is occupying battle position 41 (Figure 2.4) with its tank platoon on the left (west), one infantry platoon in the center, and another on the right (east). The infantry faces the woodline 500-750m to the front. The MAWs and a light tank section fire to cover the eastern tank approach, while both HAWs and the heavy tank section cover the main tank approach on the west.

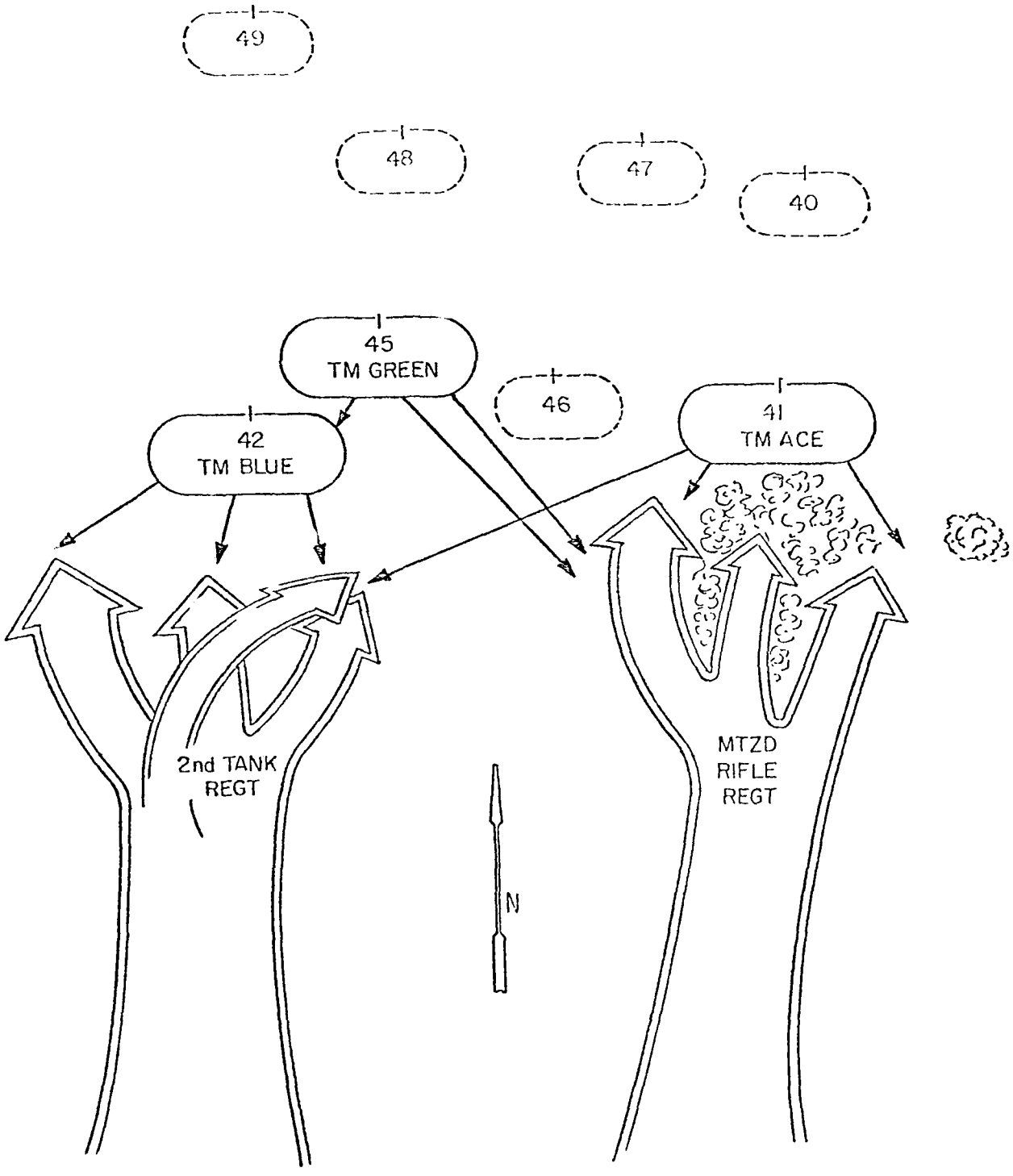


Figure 2.2: The enemy reinforces the advancing tank regiment with a second regiment causing BP 46 to become crucial to stopping the break-through attempt.

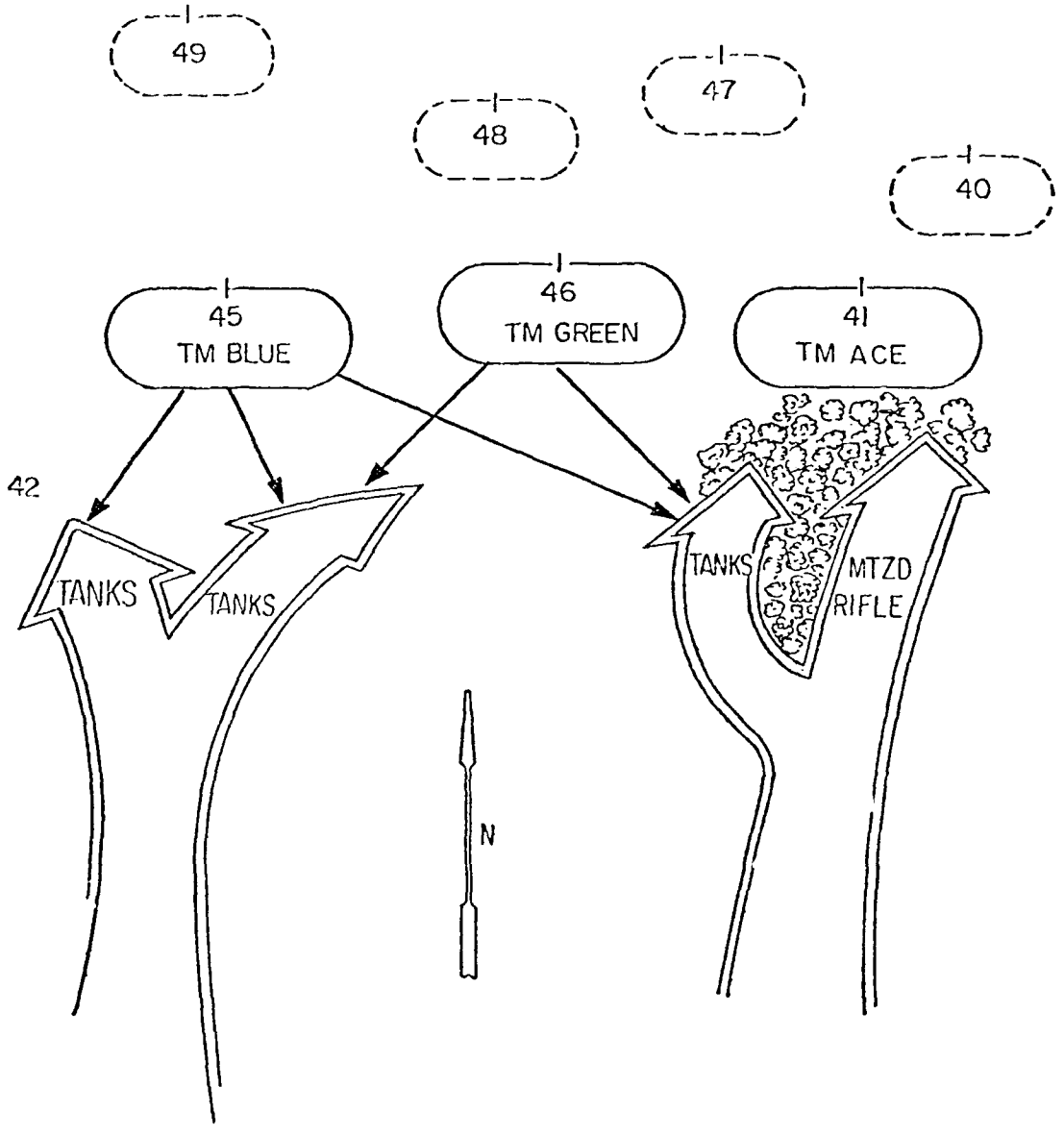


Figure 2.3. TM GREEN has occupied BP 46. TM BLUE has been forced to fight from BP 45.

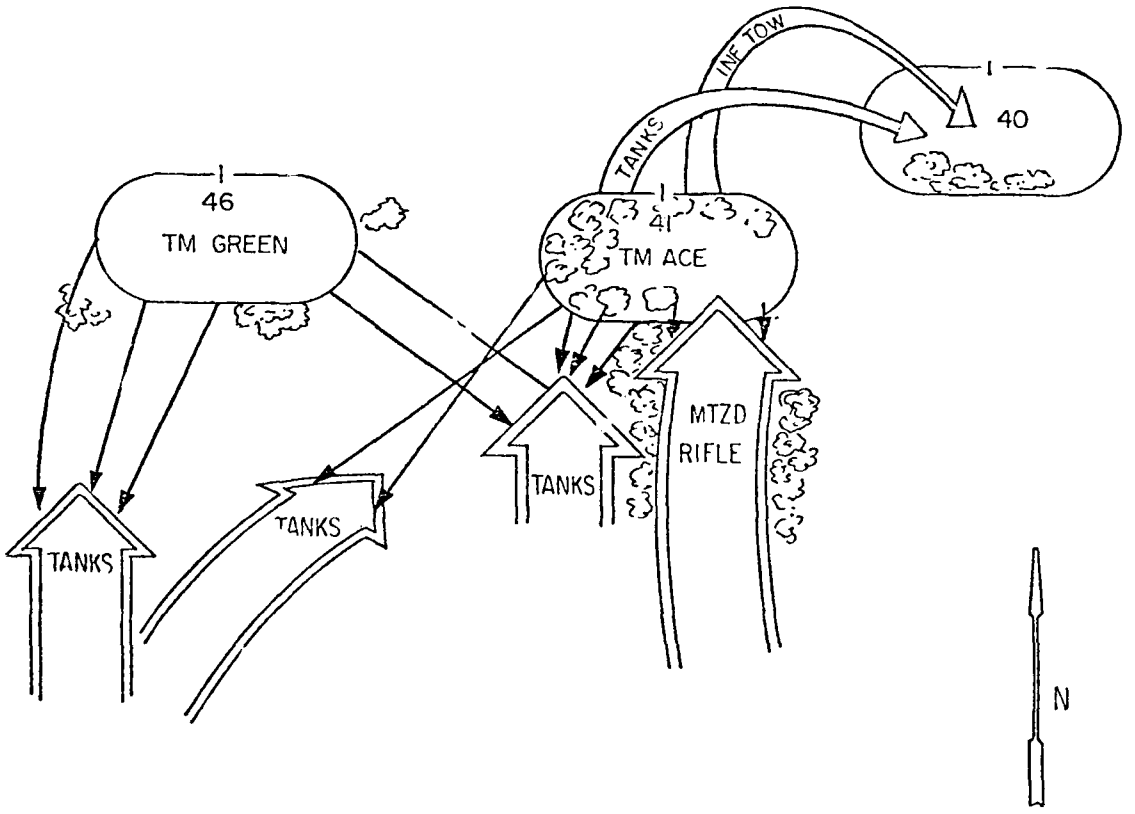


Figure 2.4. TM ACE moves to BP 40. This move is described in Platoon Action 3.

As soon as TM GREEN closes on BP 46 to the rear, the task force commander orders TM ACE to disengage and withdraw. By this time, enemy infantry has closed to 300m and enemy tanks are within 1,000m to the southeast and 1,500m to the southwest.

TM ACE commander calls for all available field artillery fire on the enemy infantry to his front and smokes the threat tank positions to the southwest. He brings his eight APCs up into hull down position and they join the field artillery in suppressing the enemy infantry to the front. Under cover of this fire, both infantry platoons regain cover and mount their carriers on the reverse slope. The two platoons plus the two HAW squads move rapidly to position 40 while covered by the tank platoon and by the fire of TM GREEN on BP 46 and TM BLUE on 45.

The schematic diagram of TM ACEs move to BP 40 is presented in Figure 2.4. "Platoon Action 3," more fully described later in this chapter, describes this action.

While TM ACE is moving, the task force commander learns that a fresh task force has arrived and is occupying battle positions 47, 48, and 49 to the rear. The task force commander orders his teams to destroy as many enemy tanks and armored vehicles as possible in the pocket southwest of Niederfullbach. Teams are to prepare to reoccupy positions 41 and 42 or counterattack weakened enemy forces in the

To help seal the pocket and to increase his antitank fire, the task force commander requests the temporary attachment of the heavy tank-team (TM TANK 70th Armor) which has just occupied BP 47.

The request is approved and necessary coordination performed as the enemy begins attacking southwest of village Niederfullbach (Figure 2.5). This attacking enemy force is the second echelon tank regiment that was weakened earlier by teams on BPs 41 and 42. The task force commander decides that he can destroy the enemy force in the pocket by the combined fire of his entire task force plus the attached team on BP 47. He orders TM TANK 70th Armor to move forward about 1,000m to good hull down firing position from which it can engage the entire attacking enemy force at long range.

The task force commander then coordinates the direct fire of all four teams by assigning them sectors of the target, using a clearly visible terrain reference point. He also calls for artillery and mortar fire (smoke and HE) to suppress overwatching enemy forces on BP 41 and in the woods to the north and northwest. The combined fire destroys the attacking enemy force and the remnants withdraw into the village.

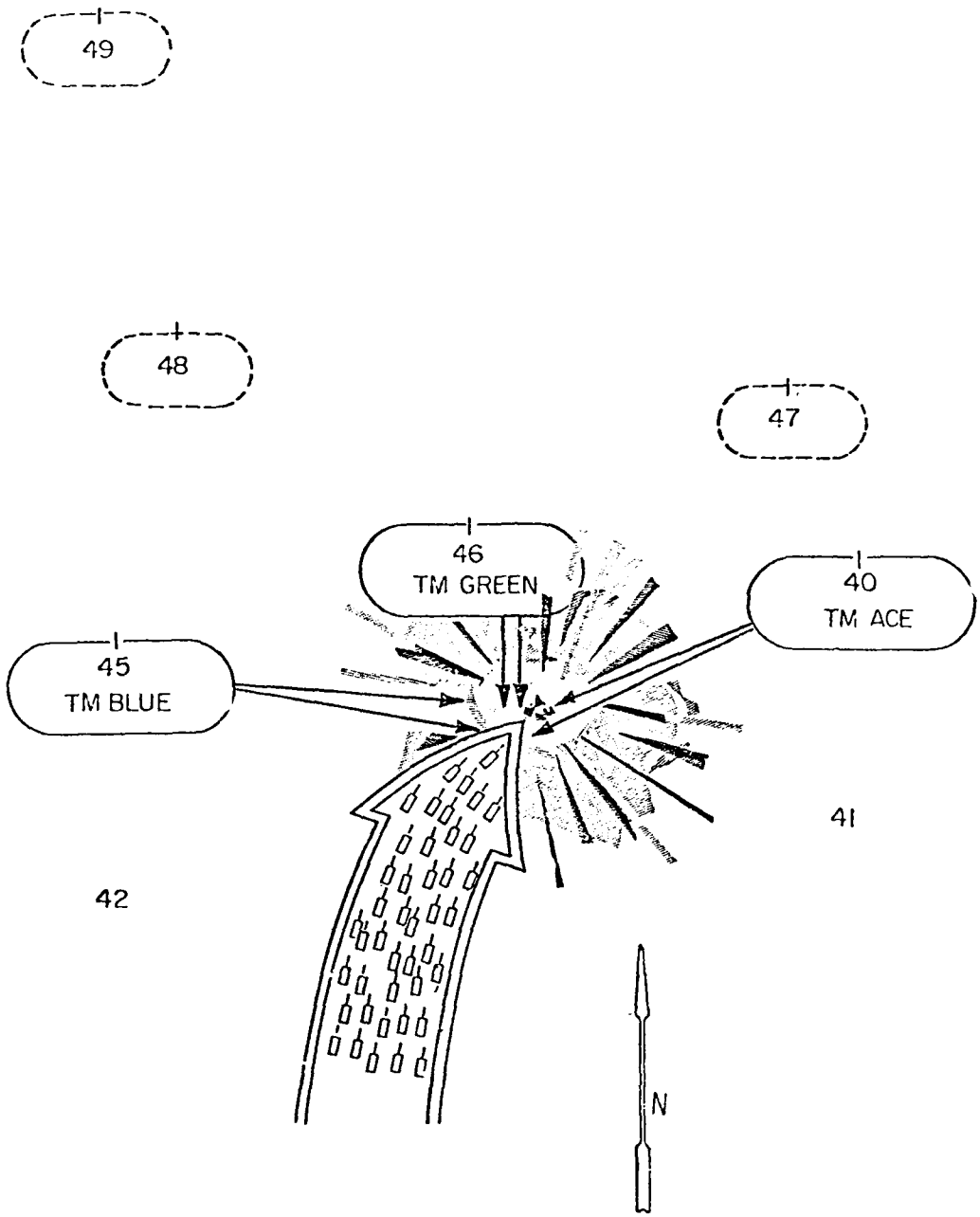


Figure 2.5. Positions of TMs ACE, BLUE, and GREEN in final defense against second enemy echelon. TF 4-78 has reinforcing units on BPs 47, 48, and 49.

In this scenario, the following principles of active defense were applied:

- the enemy rate of movement was slowed
- the enemy was engaged at maximum range
- the defense was kept flexible and elastic
- teamwork between company teams was used to coordinate fire and movement
- weakened enemy forces were destroyed.

Part II--Narrative for Team ACE (Mechanized-Infantry)

Platoon Action 1, Repel an Enemy Assault from a Battle Position

The goals of Platoon Action 1, repel on enemy assault from a battle position, are to:

(1) block the penetration

(2) destroy or eject enemy

(3) reduce penetration

(4) regain lost portions of BP.

TM ACE has had adequate time to occupy and prepare BP 41. Monitoring the BN/TF CMD NET, the TM ACE CDR hears the TM BLUE CDR report that an intense artillery and smoke preparation has begun on his BP. Shortly after this report, the HAW section sergeant reports on the TM CMD NET he has sighted a large formation of enemy tanks moving rapidly toward TM BLUE on BP 42 from the south, beyond the range of his HAWs. The artillery FO attached to the TK PLT requests ICM; the FIST chief monitors and reports this request to TM CDR via wire (Figure 2.6).

The second Mech PLT LDR reports sporadic but intense enemy artillery fires starting to fall forward of his position. The TM CDR passes both reports to the TF CDR. The HAW section sergeant requests permission to engage enemy tanks that will be almost within maximum range of the planned oblique fires of the TOWs. The TM CDR grants that request. One minute later, the HAWs fire. The artillery FO with the TK PLT reports that the effects of the ICM immobilized three enemy tanks and that the enemy is moving into an assault formation oriented on BP 42. (Figure 2.7). The HAW section leaders reports two tanks destroyed.

The TK PL reports observing several antitank weapon signatures on overwatching positions southeast of BP 42. He requests 4.2" mortars fire immediate suppression of TRP 1. 4.2" FO requests TRP 1.

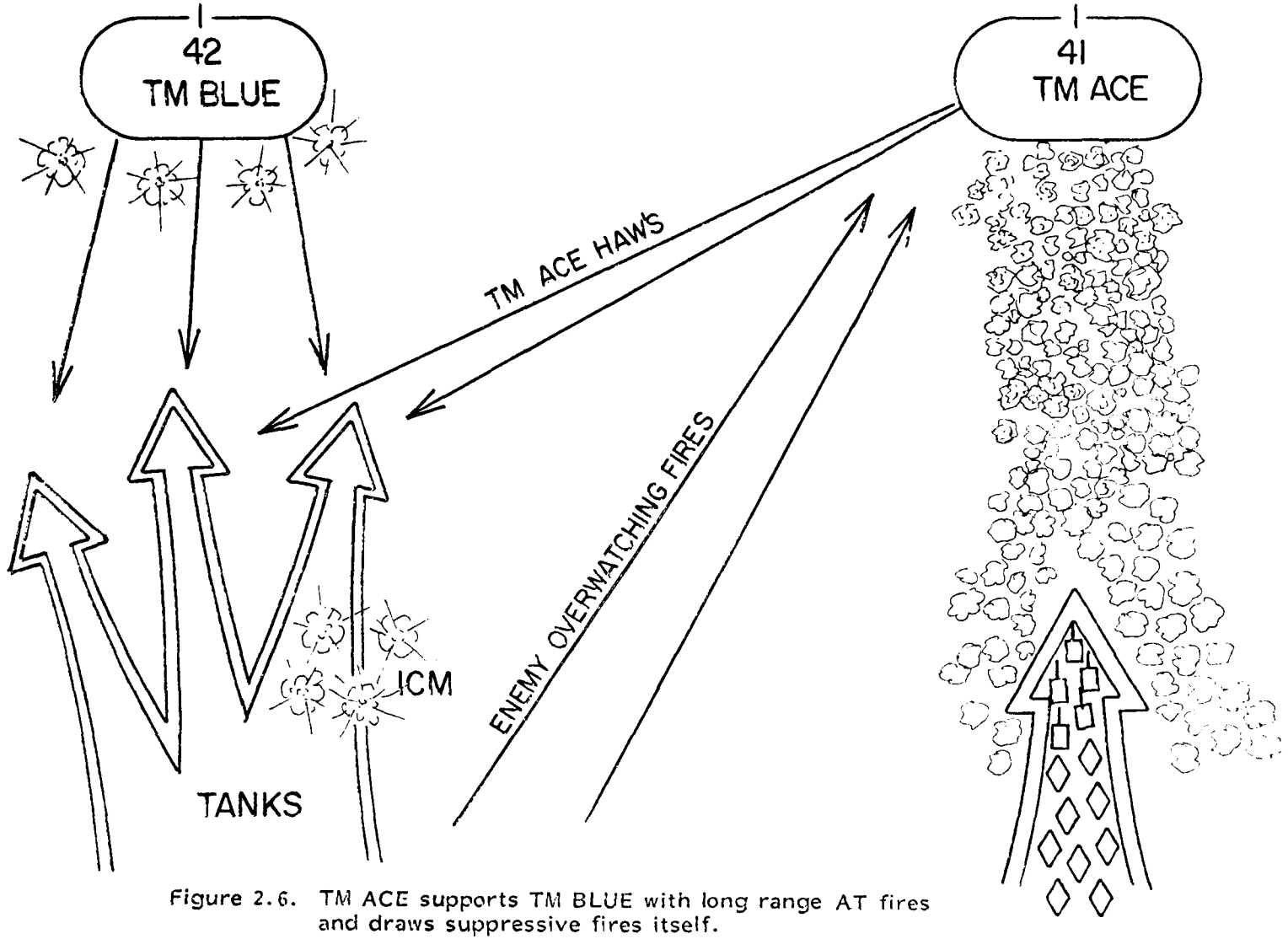


Figure 2.6. TM ACE supports TM BLUE with long range AT fires and draws suppressive fires itself.

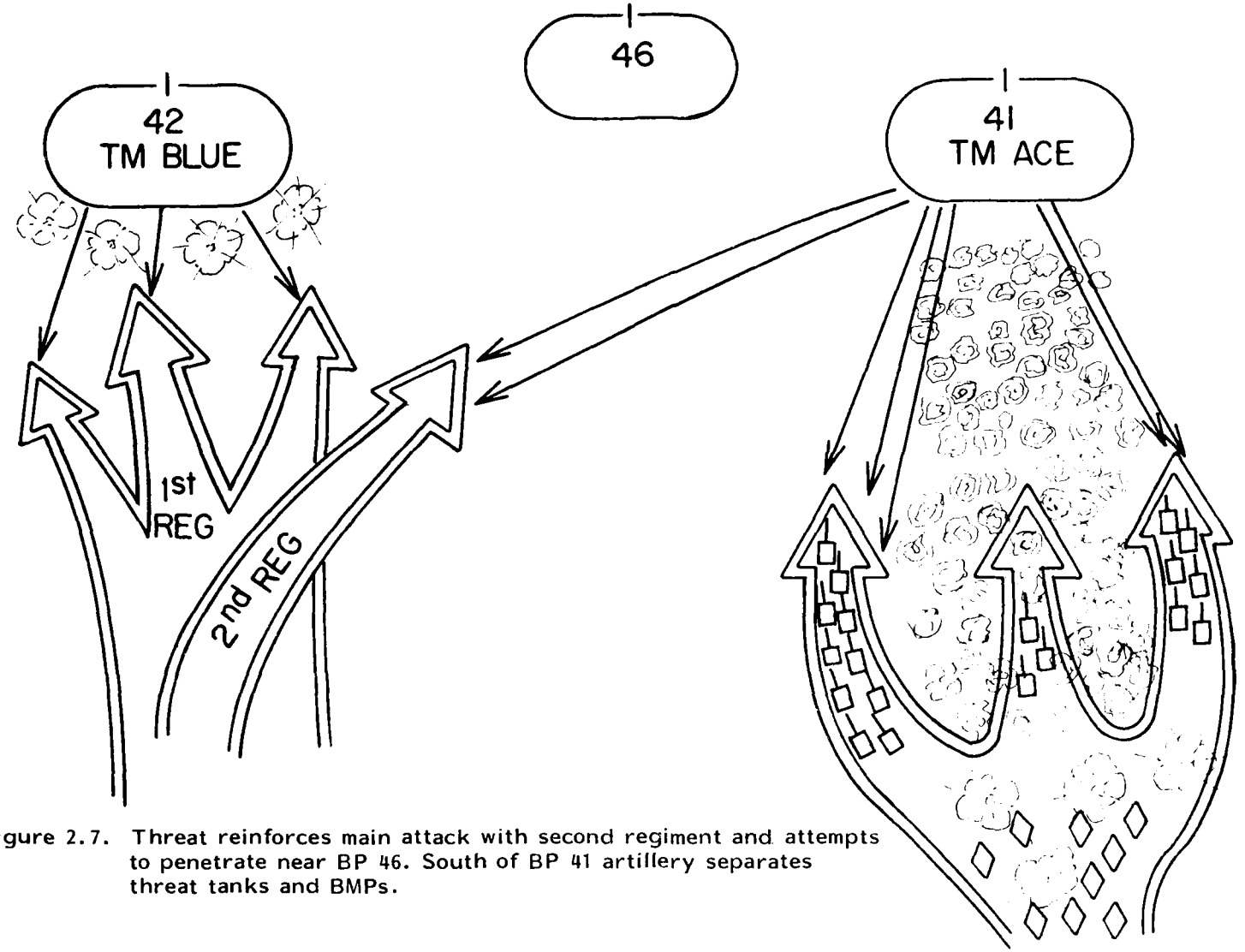


Figure 2.7. Threat reinforces main attack with second regiment and attempts to penetrate near BP 46. South of BP 41 artillery separates threat tanks and BMPs.

The third PLT leader reports sighting three enemy tanks followed by several BMPs approaching BP 41 from the south moving slowly through the woods. The second PLT leader confirms hearing tanks moving in the woods, but reports no actual sightings. He requests TM CDR fire target group 1 to force the enemy to deploy. The FIST monitors and directs a call for fire to the FSO for a General Support Unit to handle.

TK PL advised the TM CDR that the enemy appeared to be reinforcing the main attack on TM BLUE. Another large formation of enemy tanks can be observed moving rapidly to the northeast in an attempt to break through between TM BLUE and TM ACE (Figure 2.7). The HAW section leader advises the TM ACE CDR that he again fired on the tanks attacking TM BLUE and is now receiving intense artillery suppressive fires. He requests permission to withdraw to positions to the rear of BP 41 before the enemy tanks close to within 1500 meters and gain a firepower advantage.

The TM CDR orders the HAW section to withdraw. The TK PL advises the TM CDR that he is engaging the tanks and estimates the enemy's lead vehicles to be 1500m southwest of BP 41. The second PL reports that firing TGP 1 stripped the BMPs from the tanks and damaged two or three BMPs. He informs the CDR that he is engaging the damaged BMPs with CLGP and the tanks with MAWs. The third PL reports destroying one tank with MAWs and that he is receiving overwatching suppressive fires from enemy antitank weapons and dismounted infantry in the woods (Figure 2.8).

TK PL reports killing five enemy tanks and receiving heavy suppressive artillery fires. The heavy section alternates between primary and alternate positions to engage the enemy. The second PL reports that the enemy has now dismounted after the second PL maneuver element engaged the lead tanks with LAW flanking volley fire killing two tanks. He requests that the LT TK section be committed to provide him additional antitank and suppressive fires. TM CDR orders the TK PL to commit LT TK section to support second PL. The TK PL orders the LT SEC LDR to orient his fire on enemy tanks attacking the second PLT on the east.

The HAW section leader reports that he is repositioned and has started firing on enemy tanks. The second PLT LDR requests 4.2" support to engage infantry and his 81mm FO requests 81mm support to engage dismounted infantry attempting to close on the platoon BP. The FS NCO redirects the request for 4.2" support to the FSO and monitors the 81mm request. The third PLT 81mm FO requests support and the FS NCO redirects the request to the FSO.

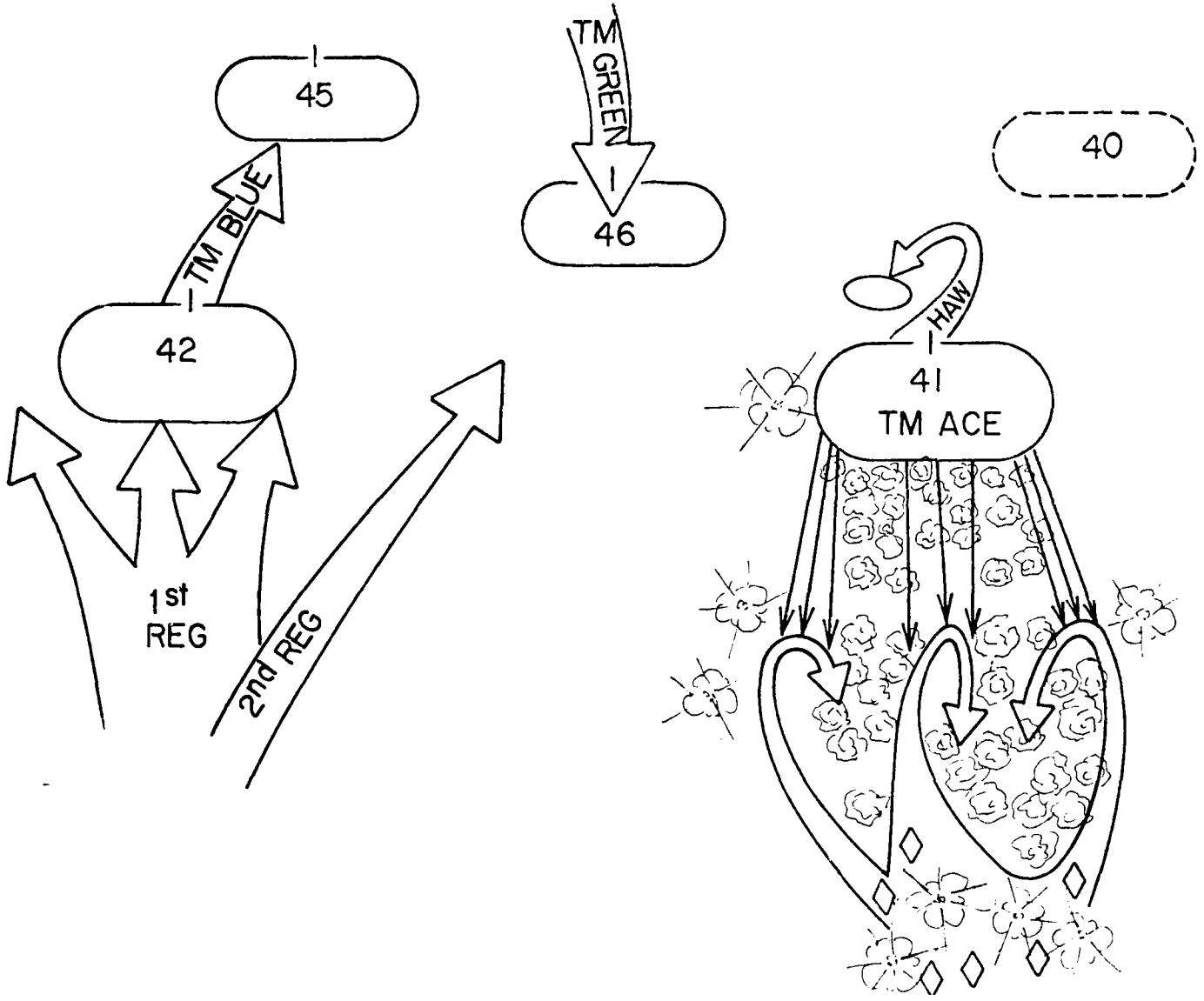


Figure 2.8. TM BLUE withdraws and second regiment regains momentum as the intense AT fires of TM ACE momentarily blunt advance of motorized regiment which dismounts.

TM ACE CDR advises TF CDR that he engaged enemy tank regiments attacking TM BLUE with HAW, TK and ICM. He is also under heavy motorized infantry attack himself, but has forced the enemy to dismount. (Figure 2.9).

The second PLT LDR advises the TM CDR that several enemy tanks are apparently attempting to by-pass his platoon's kill zone and move along the western edge of the tree line toward the TK PLT. (Figure 2.9). The TK PL reports that an estimated 10 to 15 enemy tanks have closed to within 500m of his position on the south. He has requested TRP 4 and engaged the enemy. The TK PL requests that the LT SEC be committed now to overwatch the withdrawal of Heavy Section. The TM CDR orders the FIST to request immediate suppression on TRP 4 and directs the Heavy Section to withdraw.

The HAW section reports that ICM and intense AT fires have blunted the penetration of the second enemy tank regiment attacking TM BLUE. The second PLT LDR reports that the enemy's volume of fire is increasing as the dismounted infantry and BMPs take up covered positions. The second PL requests TGP 1 be refired. The FIST Chief monitors and advises the TM CDR he may refire TGP 1 in two minutes. The TM CDR approves and advises the second PL. The FIST Chief orders the FS NCO to order 81mm fire on TRP 1, the 4.2" FO to fire on TRP 2 and requests TRP 3 for himself.

TK PL reports that the LT SEC has killed four enemy tanks and that fires on TRP 4 have rechanneled tanks into second PLT kill zone. The second PL reports that the firing TGP 1 have stopped the momentum of the enemy assault and the enemy is apparently withdrawing. The third PL confirms that the enemy is apparently withdrawing to regroup. The TM CDR relays the casualty and damage estimates, and reports his status to the TF CDR.

Platoon Action 2, Create and Defend a Strongpoint

The goals of Platoon Action 2, create and defend a strongpoint, are to:

(1) retain or deny terrain

(2) gain time

(3) wear down enemy attack force

(4) destroy weakened enemy forces.

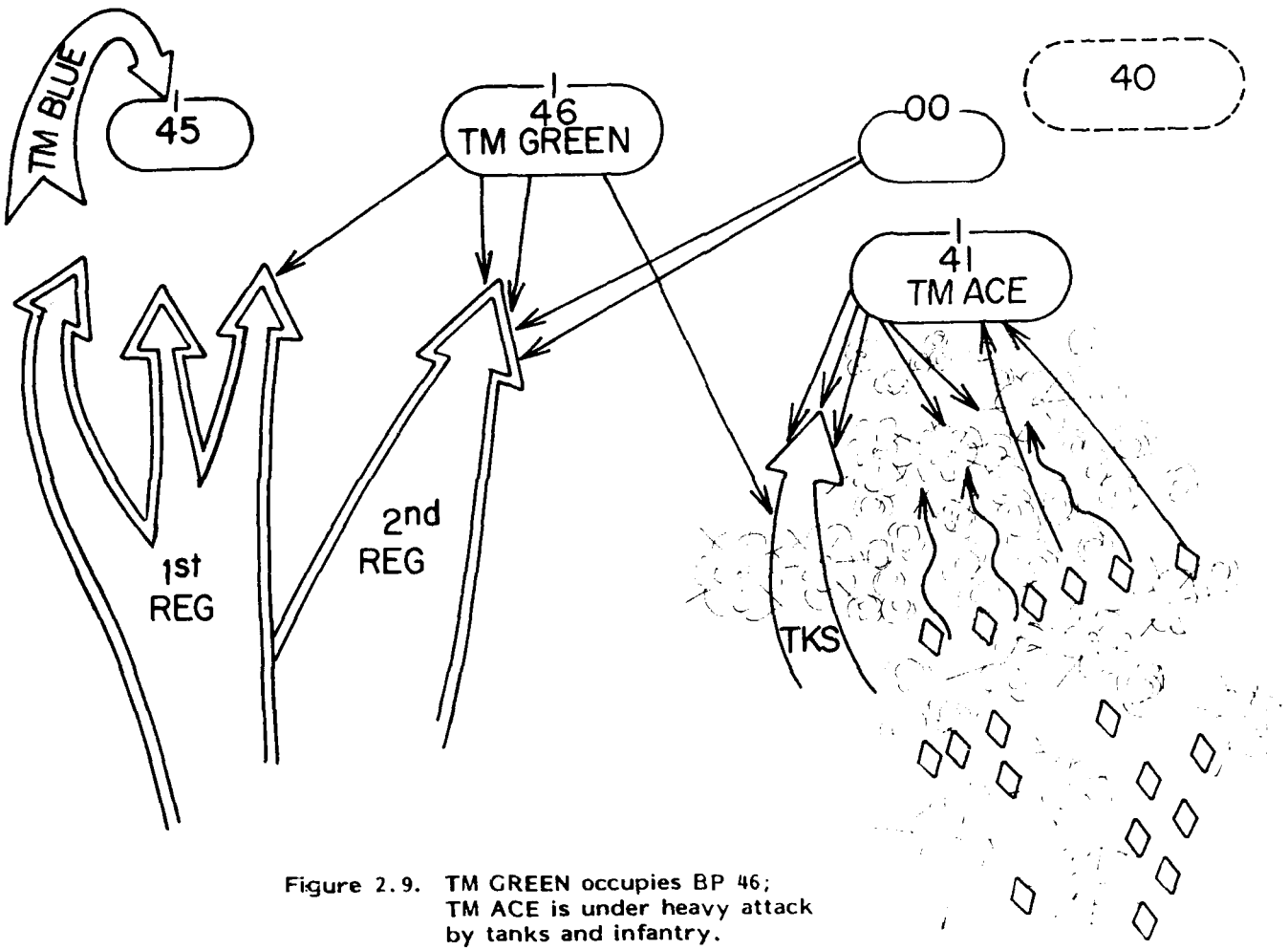


Figure 2.9. TM GREEN occupies BP 46; TM ACE is under heavy attack by tanks and infantry.

The Task Force Commander had ordered the immediate implementation of the task organization presented at the start of the task force scenario. TM ACE was ordered to detatch one mechanized platoon and to have attached to it one tank platoon and one heavy antitank section. In addition, the heavy mortar platoon was to dispatch one toward observer party to TM ACE and the direct support artillery battalion was to send a FIST to TM ACE consisting of a three man headquarters section and three toward observer parties.

Upon receipt of the TF CDRs order, the TM ACE CDR issued a FRAGO detaching one of his organic mech platoons. That PL in turn ordered his platoon to make ready to move to the vicinity of TM TANK while he reconed a covered and concealed route. Having done this, the PL returned and the mech platoon moved as quickly as possible to join TM TANK. The PL instructed his RATELLO to request permission from the TM ACE net control station to leave the TM ACE command net and to then establish communication and enter the command net of TM TANK. The PL ordered the 81mm FO team from the company motar platoon to return to the company CP to be reassigned to the TK PLT when it arrived. Similar procedures are executed by the TK PL at his location.

Meanwhile, the HAW section sergeant enroute with his element to join the TM ACE requested permission to enter the command net of TM ACE. The NCS requested authentication and with authentication correctly given allowed the HAW section to establish communication with TM ACE. Similarly, the 4.2" mortar FO was dispatched and moved to the command post of the TM ACE CDR. The FIST Chief enroute, also contacted the TM ACE NCS and requested permission to enter the TM ACE command net. The FIST Chief was challenged, he authenticated properly and was allowed to enter the net. The FIST moved to the TM ACE CP to report to the TM ACE CDR.

While awaiting the arrival of the attached elements, the TM CDR issued a warning order to his organic platoons and moved to recon the battle position he was ordered to occupy. There the TM ACE CDR determined the exact placement of each of HAW and considered the general positioning of each platoon based on his analysis of the military aspects of the terrain in the vicinity of the BP. Next, he considered a general fire support plan and the location of observation posts. He selected a command post location, supplementary positions, and reconed withdrawal routes. The TM ACE CDR then began to prepare a terrain sketch depicting the BP and the location of key weapons, platoons, obstacles and target reference points. He prepared his defensive operations order and a terrain model to use when issuing the order to the subordinate leaders later.

The 4.2" FO party was the first of the attached elements to reach the TM ACE CP. The TM ACE ISG directed the FP party to the TM ACE CDRs location at BP 41. The 4.2" FO party proceeded to the BP where the TM ACE CDR quickly briefed the FO and ordered him to begin selecting vantage points and preparing a target list. He pointed out the exact location of the 4.2" FPF he was granted by the TF CDR and told the 4.2" FO to adjust the FPF.

Shortly after that the FIST arrived at the TM ACE CP and was directed to the CDRs location by the ISG. Meanwhile, platoon guides dispatched earlier to the TM CP by each platoon leader lead the FIST FO parties to their respective mechanized platoon CPs. One FIST FO party remained at the CP awaiting the arrival of the TK PL.

At the BP the TM CDR briefed the FIST Chief when he arrived and ordered him to coordinate with the 4.2" FO to complete the TM fire plan.

The HAW section arrived at the TM CP and was also directed to TM CDRs location. When the HAW vehicles arrived, the TM CDR positioned the two vehicles himself, ordered the section sergeant to place out observation posts and keep watch in the most likely armor avenue of approach.

Finally, the TK PLT arrived at the TM ACE CP. The PL is joined by the 81mm FO and the FIST FO who accompany him to the TM ACE CDRs location. At the TM CDRs location the TK PL reports to the CDR who has ordered his mechanized platoon leaders to join him with their FOs. The key leaders assembled, the TM CDR issues his defensive order using the prepared terrain model to display his proposed defensive deployment (Figure 2.10). He orders the TK PLT to select positions on the western third of BP 41 overwatching the HAW positions and having a primary sector of fire toward TM BLUE toward the west. He orders the TK PL to place the LT SEC where it can overwatch the 2nd platoon which will be occupying a platoon BP in the center of BP 41 oriented to the south and located east of the TK PLT.

The TM CDR instructs the 2nd platoon to position its support element in reverse slope hide positions while the maneuver elements take positions in the woods where they can provide security for the tanks and block the infantry approach through the woods south and east of BP 41. One squad will be detached to secure the HAWs and TKs.

The TM CDR orders the 2nd platoon to occupy a BP on the northeast third of BP 41 placing the support element in reverse slope hide positions and the maneuver element found in the woods oriented to the southeastern infantry approach through the woods.

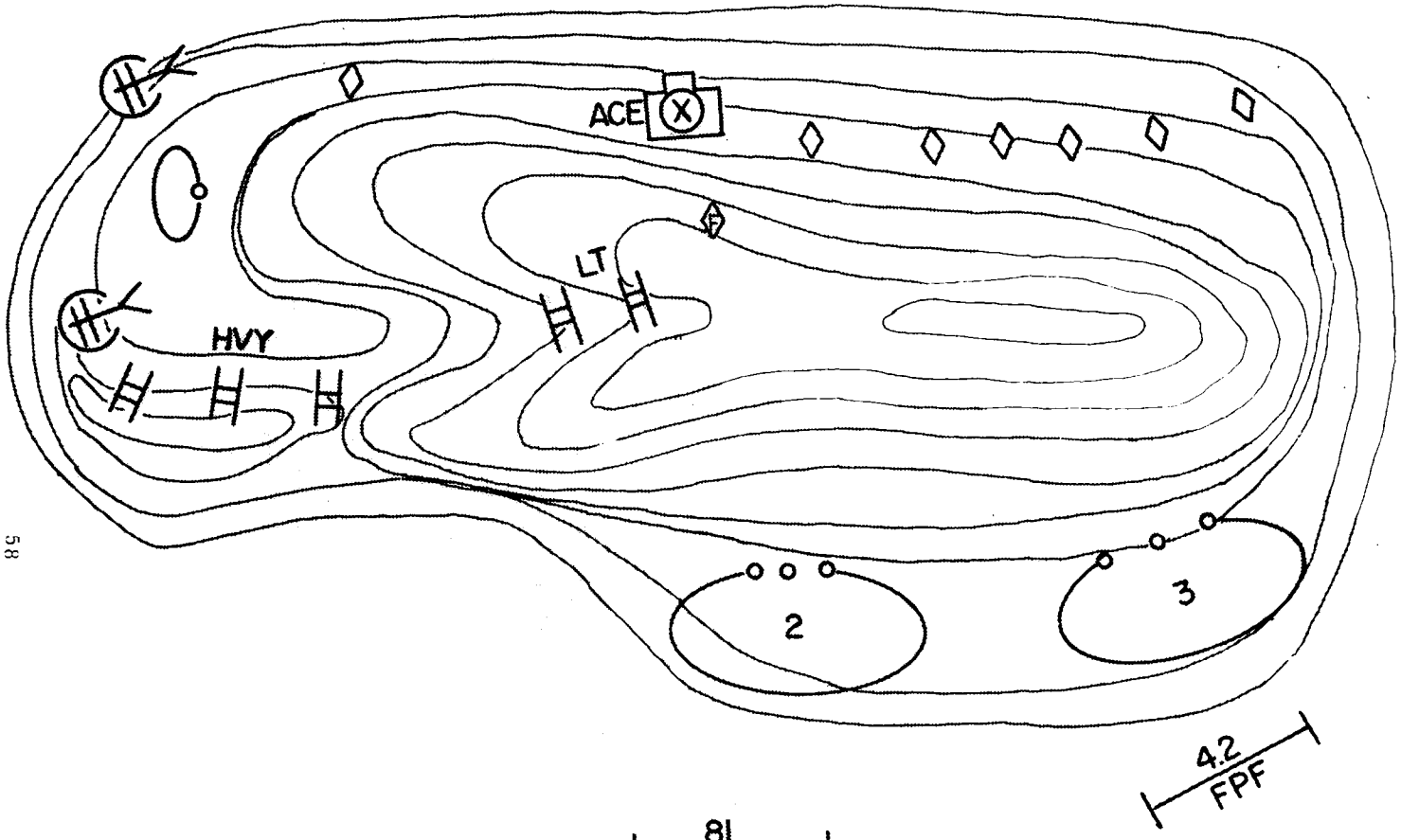


Figure 2.10. TM ACE on BP41.

The 81mm mortar is ordered to locate on the reverse slope of the hill to the rear of BP 41. All of the platoons are ordered to place out security, prepare fields of fire, dig in and camouflage, establish wire communications, and employ claymores and wire obstacles. The executive officer is ordered to recon and mark positions on BP 40. PLs are ordered to be prepared to occupy it on order. The commander instructs the 2nd platoon to adjust the 81mm FPF 200m in front of BP 41. He established the right limit of fire for the platoon and HAWs, informing both that they have permission to request and adjust artillery fire or to engage enemy tanks at maximum effective ranges forward of TM BLUE's BP. The TM CDR orders the FIST Chief to consolidate the TM target list and overlay for dissemination to each leader. He discusses the TM chain of command, the CP location, and the use of control signals.

The PLs, upon receipt of the TM CDRs order, prepare a reverse planning sequence and issue warning orders that they dispatch via messengers to their respective platoons. They coordinate with each other and the FIST Chief, then move to recon their respective platoon BP's. Each PL carefully selects the initial positions for his machine guns, MAWs, support vehicles and maneuver squads. Each PL has the artillery FO and 81mm FO prepare a platoon fire plan and target list. The FIST and the team CDR continue their fire planning activities by moving from one platoon BP to the next selecting OPs, covered and concealed routes, and gathering target information from the FOs.

Finally, the TM CDR orders the TM to move to the BP. The TM moves forward under the control of the 1SG and each PL takes charge of his platoon when it arrives. As the PLs position their elements, the TM CDR checks their position selections beginning with the TK PLT since the TK PL is unfamiliar with his company's operational procedures.

The TM CDR inspects each platoon BP making on the spot corrections as required. He checks to see that fields of fire are interlocking and mutually supporting among the platoons. He determines whether the positions are adequately prepared, covered, and concealed. He insured that wire communications are in place and operational.

The FIST submits the TM target list and overlay to the TM CDR for approval. The TM CDR reviews it, makes necessary alterations, and orders it forwarded to the FSO. He reports the mission status of his unit to the TF CDR and requests any additional support he may need in preparing the defensive position such as mines or engineers and equipment. Finally, he coordinates with his executive officer who has been given the task to recon and make subsequent battle positions to the rear so as to facilitate withdrawal and occupation later.

Platoon Action 3, Disengage and Occupy a New Battle Position

The goals of Platoon Action 3, disengage and occupy a new battle position, are to:

(1) maintain ability to move

(2) control essential terrain

(3) maintain tactical objective (secure assigned BP)

(4) preserve forces

Due to the overwhelming numbers of threat forces the TF CDR decided to have team ACE disengage and withdraw under pressure and to occupy a new battle position to the rear of BP 41.

The TF CDR orders TM GREEN to occupy BP 46 and TM ACE to withdraw to BP 40. The TM ACE CDR orders the HAW section to disengage and displace to BP 40. He orders the 3rd platoon to disengage, move to BP 40 and overwatch the withdrawal of the rest of the TM. (Figure 2.10).

The 2nd PL reports that the enemy has resumed the assault behind an intense artillery barrage. The TM CDR orders the 2nd PL and the TK PLT to hold for 15 minutes. He orders the FIST to refire TRP 4 with smoke and also to refire Target Group 1.

The HAW section leader reports that he is in position on the BP. The 3rd PL reports that he is enroute. The 2nd PL reports that the enemy has closed to less than 300m and he requests 4.2" and 81mm FPFs. The TK PL reports that the Heavy Section is being forced to abandon its primary positions because of intense tank fire. The Light Section is overwatching that withdrawal. FIST monitors and advises TM CDR to fire FPFs, withdraw the 3rd PLT while FIST adjusts ICM and CLGP to cover the tank platoon.

The CDR orders FPFs fired, orders 2nd PLT to disengage and move to the BP. The CDR requests TM GREEN and TM BLUE to engage enemy tanks on the western edge of BP 41. The FIST Chief reports that ICM has immobilized three enemy tanks and that he is engaging them with CLGP as the FS NCO adjusts ICM. Heavy AT Fires from TM BLUE and TM GREEN combined with the intense artillery fire finally permited TK PLT to disengage. FIST adjusts smoke while all of TM ACE moves to occupy BP 40 (Figure 2.11).

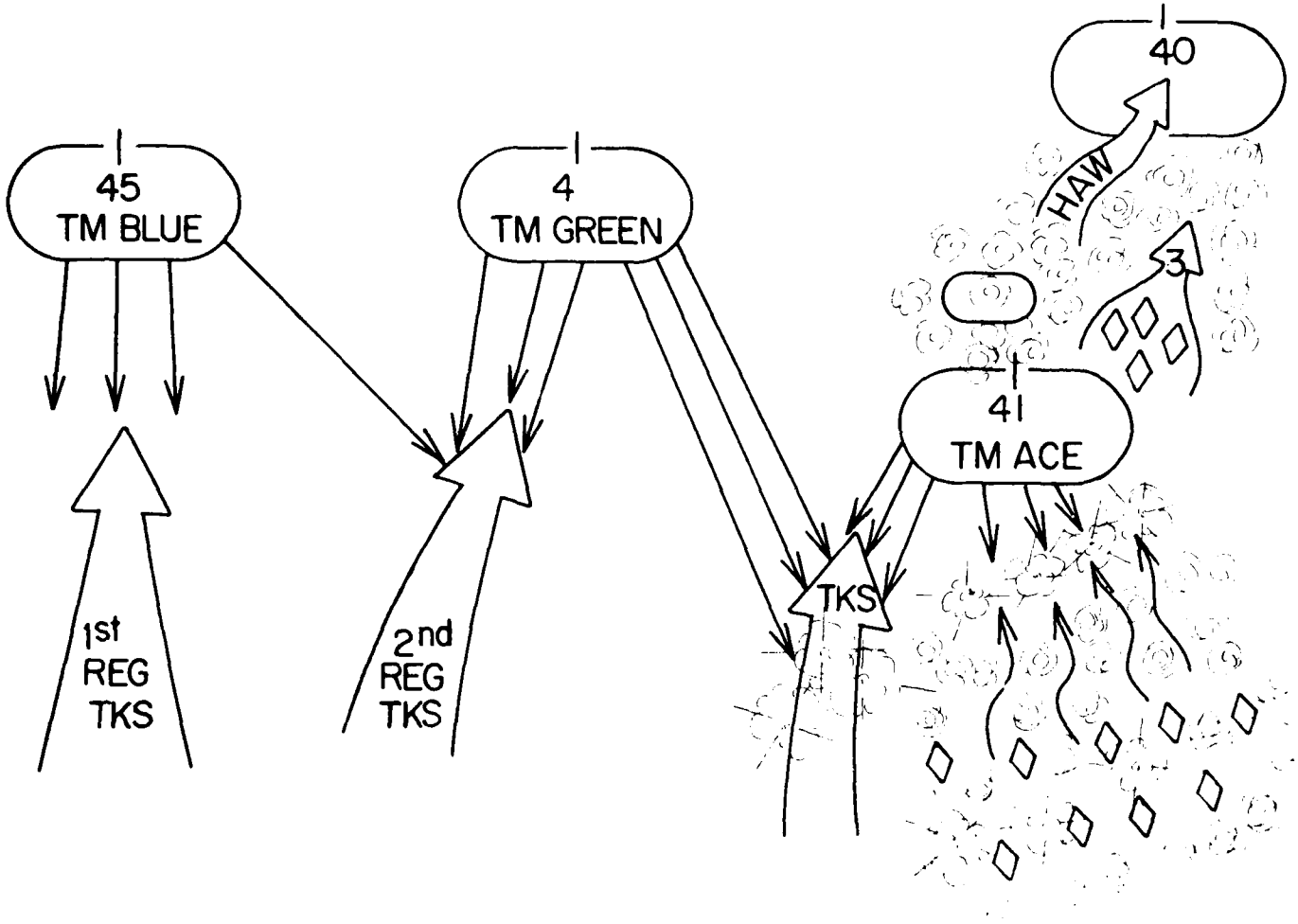


Figure 2.11. Team ACE begins to disengage as threat forces close in dismounted through the woods.

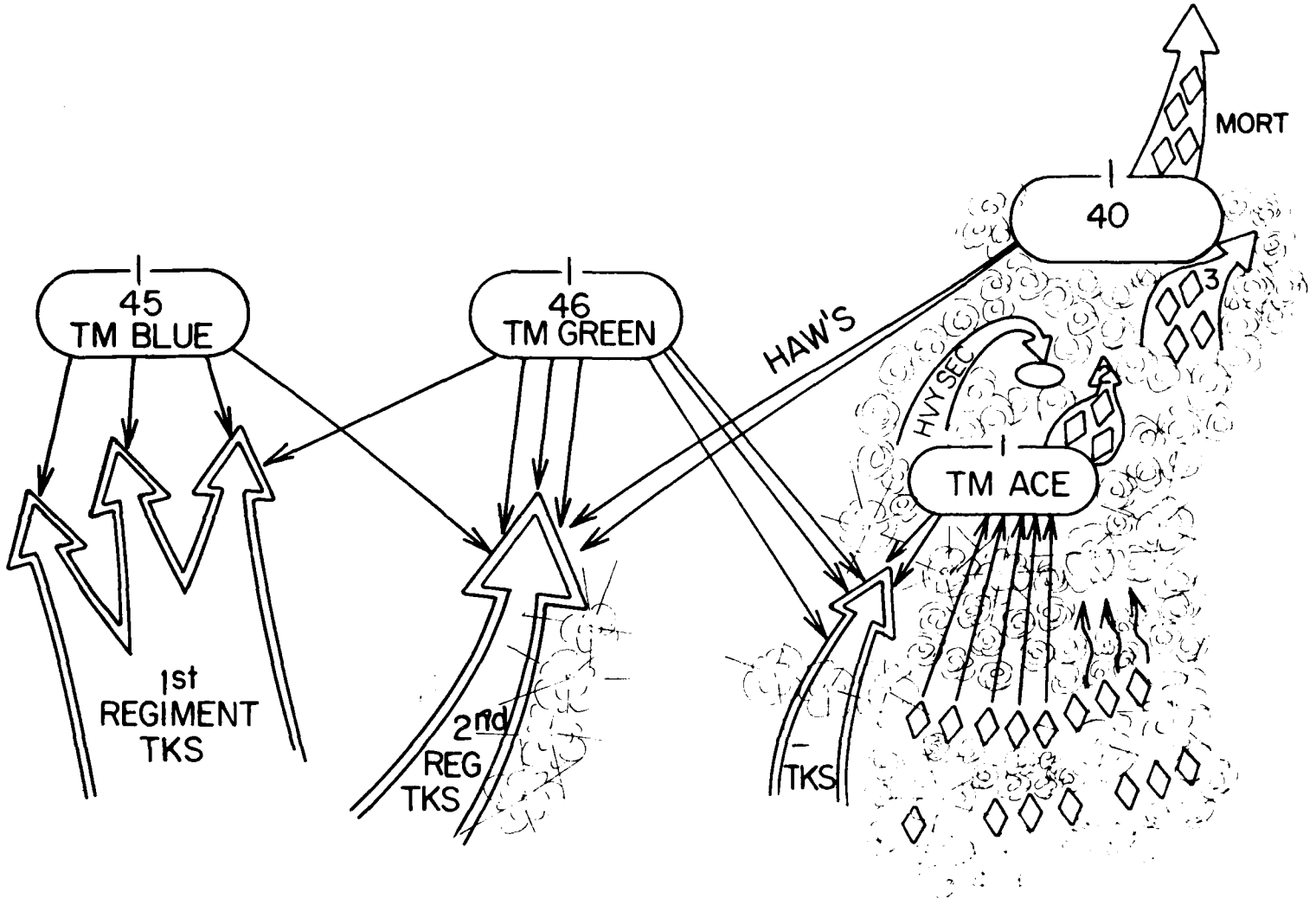


Figure 2.12. TM ACE CDR orders tank PLT to hold until MECH PLTs can complete withdrawal. FPFs requested.

Part III--Narrative for Team ACE (TK PLT)

Platoon Action 1, Repel an Enemy Assault from a BP

This part of the scenario depicts the actions of the TM ACE TK PLT in repelling an enemy assault on BP 41. It describes how the tanks initially engage the attacking enemy tanks with long range, oblique fires. Later, the tanks are shown overwatching the mechanized platoon which is being attacked by dismounted motorized infantry elements. Finally, the tank platoon must engage enemy tanks at much closer range while under heavy pressure.

In preparing to defend so as to retain BP 41 the TM ACE Commander positioned his two mechanized PLTs along the infantry avenues of approach into BP 41, i.e., the woods to the south and east of BP 41. The TK PLT has been positioned astride the primary armor avenue of approach, i.e., the open terrain to the south and west of BP 41. During earlier coordination with the TM BLUE CDR, the TM ACE CDR determined that initially the best long range fields of fire for the tanks and HAWs favored use of oblique fires forward of TM BLUEs BP. Together the two TM CDRs established an acceptable right limit of fire for TM ACE to prevent the tanks and HAWs from firing into TM BLUEs BP but permitting TM ACE to engage any enemy tanks attacking TM BLUE at maximum effective ranges. The TF CDR has directed that all TMs concentrate AT fires on the armor avenue of approach, since that is where the enemy penetration attempt will most likely occur.

The TM ACE CDR directs the TK PL to position his Heavy Section so that its primary section of fire is across the front of BP 42. He tells the TK PL to be prepared to engage enemy tanks at maximum effective range. The primary tank positions selected by the TK PL should be as far forward on BP 41 as possible, covered and concealed, and provide long range fields of fire. Alternate positions should also be well forward and provide long range fields of fire in the same sector. Supplemental positions will be selected on the eastern slope of BP 41 along the second most likely enemy armor avenue of approach. The TM ACE CDR orders the TK PL to position the light tank section where it can cover the armor avenue of approach into BP 41 along the western edge of the woods to south of TM ACEs position. The TM ACE CDR positions the two HAW vehicles well forward on BP 41 and gives them the same section of fires as the tank Heavy Section (See Figure 2.6).

The TK PLT LDR selects the primary positions for his Heavy Section on the reverse slope of a ridge in the tree line on the southwestern edge of BP 41. Each tank is capable of overwatching the two HAW vehicles which are even farther forward. The Light Section is positioned on the reverse slope of BP 41 overwatching the Heavy Section and where it is capable of firing in support of the 2nd PLT which is deployed on the left to the east of the TK PLT.

Intense enemy artillery preparation fires begin falling on TM BLUE and a large formation of enemy tanks is reported attacking from the south in the direction of BP 42. Heavy enemy tank fires are reported by the TM BLUE CDR. The TM ACE CDR orders the HAW gunners to commence firing on the enemy tank formation as soon as the flank tanks are within range. The TK PL Orders his gunners and commanders to track and range the enemy tanks, but to hold their fires until the tanks are within 1500m. The HAW section sergeant reports two tanks destroyed by the TOW fires.

The TK PL orders the artillery FO to request and adjust ICM on the enemy tanks. The HAW section sergeant reports two more tank kills and that he is now reserving heavy enemy suppressive fires. He requests HE/SMOKE on TRP 7. FIST redirects the call to the FSO, and is permitted HE but no smoke.

The TK PL orders the Heavy Section to begin to engage the assaulting tanks with an oblique volley while the HAW section moves to its alternate firing positions. After firing the first volley, the Heavy Section immediately moves to its alternate firing position and fires a second oblique volley. The TK PL reports four apparent kills and ineffective artillery fires attempting to suppress his primary position. The HAW section reports one more tank destroyed and heavy enemy antitank suppressive fires continuing to come upon his new position.

The 2nd PL requests tank support to combat tanks and motorized infantry that are closing on his BP through the woods. The TM ACE CDR orders the TK PL to commit the Light Section. The TK PL orders the Light Section to move into firing positions from which it can support 2nd PLT. The HAW section sergeant advised the TM ACE CDR that the enemy tanks soon will be within effective tank cannon range of his position and requests permission to disengage and withdraw before the enemy tanks gain full fire power advantage. The TM ACE CDR consents. The Heavy Section continues volley fire as the HAW section begins withdrawal.

The 2nd PL reports enemy tanks attempting to bypass BP 41 on the western edge of the tree line south of the tank Heavy Section. The 2nd PL requests TRP 4 be engaged with ICM to blunt this envelopment. FIST directs the CFF to its battery and moves to another BP to observe effects. The TM ACE CDR orders the TK PLT to cease oblique fires and to long range reorient on the tank threat to the south of BP 41. The TK PL with the Heavy Section reports is already heavily engaged with the head tanks of the enemy's enveloping element. The TK PL requests artillery to cover his withdrawal, to his original positions. The FIST monitors, requests ICM and smoke adjusted from TRP 4 to engage the approaching tank threat.

The TM ACE CDR orders the TK PL to have the Light Section reorient its fires on the enemy tank threat, also. The TK PL reports the ICM, smoke and covering fires of Light Section have momentarily disrupted the enemy

tank formation and that he has moved successfully to his original firing positions. The TM ACE CDR requests that TM BLUE and TM GREEN now be committed to begin to engage enemy tanks attempting to bypass on the West of BP 41 along the wood line. The HAW section reports engaging tanks of the enemy second echelon approaching TM GREEN's BP.

TM BLUE CDR reports that the enemy tanks attacking his position have regained momentum since TM ACE AT fires were reoriented against the tank to BP 41. TM BLUE CDR reports the head tanks of the enemy's second echelon have closed to less than 1500m of TM ACE in the west. The enemy appears still to be making an attempt to penetrate between TM BLUE and TM ACE.

Meanwhile, TM GREEN has been ordered to occupy BP 46 to block the penetration. AT fires from TM GREEN are used to engage the enemy south of BP 41. TM ACE FIST continues to request and adjust smoke and ICM on the tanks west of BP 41. Together the AT fires and the ICM prevent the second echelon from enveloping BP 41 on the west. Meanwhile, 2nd PLT has succeeded in stripping the enemy infantry from the enemy tanks east of BP 41. The Light Section reports that is is providing highly effective overwatching fires for the Heavy Section.

The TM ACE CDR advises the TF CDR that the enemy has dismounted to the southeast of BP 41 and closed to less than 300m while the enemy tanks continue to attempt to penetrate west of BP 41. The BN/TF CDR orders TM ACE to begin to disengage and withdraw to BP 40.

Platoon Action 2, Create and Defend a Strongpoint

This part of the scenario describes how the TK PLT is integrated into the defense of the battle position. Techniques for controlling platoon fires, for preserving the tanks themselves, for insuring freedom to maneuver, and for firing in support of the rest of the company/team are detailed.

Upon receipt of the Team Commander's order to occupy and prepare BP 41, the TK PL issues a warning order to his platoon and proceeds to the BP to conduct his reconnaisance. Based on the TM CDRs order, the TK PL selects positions for his Heavy Section. The positions are oriented on the enemy armor avenue of approach to the west and south. Each tank is given a hull down position from which to fire that is concealed and provides long range fields of fire. The positions selected also permit the tank fire to be interlocking and mutually supporting. The PL surveys the platoon sector and selects individual sectors for each tank. He determines the necessary limits of fire, right and left, for each tank commander to observe.

This completed, the TK PL next recons covered and concealed routes to nearby alternate firing positions. There he again surveys the platoon sector to insure that it is adequately covered by fires delivered from the alternate position. From there he moves to select primary and alternate positions and routes for the Light Section.

In both cases the TK PL directs the 81mm FO and the artillery FO to prepare indirect fire plans to support his defensive position. Emphasis here is on selecting targets on known, suspected, and likely enemy positions and to plan for targets in front of, on top of and behind the TK PLT BP. The FOs must also select observation posts and routes they can use to move from one to another as required.

The TK PL orders the TK PLT forward and directs the Heavy Section into the preselected firing positions. He indicates the sectors of responsibility for each tank commander in both Light and Heavy Sections. The gunners and tank commanders place out local security and begin calculating range, azimuth and ballistics data for their sector targets.

The PL prepares a terrain sketch and consolidates the TK CDRs range and duplicates it into a platoon range card. He approves the FO target lists and orders the list sent to the FIST. When the target numbers have been assigned by the FSO and the list is returned he places them on his target sheet. Reviewing the indirect and direct fire target lists, the PL plans for the method of fire and the control measures he will use to coordinate platoon fires after the assault on his BP begins. He plans for crossing, flanking oblique, volley, and individual tank fires. He plans for the employment of organic illumination and for artillery illumination. The TK PL orders that hot loop communications be emplaced and quickly inspects the camouflaging activities of his TK CDRs.

Whenever, the PL is satisfied with the preparation of the primary positions he will instruct the TK CDRs quickly to prepare the alternate positions before resting. Again the TK CDRs and gunners prepare range, azimuth and ballistics data for sector targets. Wire will be laid so that it is available for use when the alternate positions are occupied.

The PL indicates the routes and indicates the routes and individual tank positions he selected at the supplementary location to the TK CDRs who will prepare them while the TK PL coordinates with the adjacent PL and FIST Chief. The leaders insure that local security, fire planning, and mutual support are complete.

The placement of obstacles, minefields, and surveillance devices is completed when the TK PLT firing positions are complete.

Platoon Action 3, Disengage and Occupy a New BP

Normally, the TK PL will be left in contact to overwatch the withdrawal of more vulnerable company team elements. The armor protection, the high volume of mixed fires, and the maneuverability of the tank make it the best choice to cover the withdrawal of other friendly elements. This scenario describes how the tank platoon operating in sections and moving by bounds effectively overwatches the disengagement of the team.

The TF CDR orders the TM ACE CDR to disengage and withdraw from BP 41 to BP 40 before becoming overrun. The TM ACE CDR orders the HAW section to disengage first and set up overwatching fires on BP 40 to cover the withdrawal of his TM. Next he orders the least engaged platoon, the 3rd, to disengage and begin the withdrawal to BP 40.

The 2nd PLT and the TK PLT are to remain in contact engaging the enemy with intense direct and indirect fires. The TM ACE CDR orders the FIST to request the 4.2" FPF and the 81mm FPF preplanned 200m forward of 2nd PLT and tells the 2nd PLT to begin disengagement as soon as the FPFs are fired. The TM ACE CDR advises the TM leaders that he is now moving to BP 40 with the 2nd PLT. The FIST remains to adjust fires to support the TK PLT with ICM and CLGP.

The TK PL advised the TM CDR that the enemy is continuing to close rapidly and requests that smoke be laid down. The FIST had already anticipated that smoke would be needed and has obtained permission from the FSO to use it. He starts to establish a heavy cloud among the enemy tanks. The TK PL reports the smoke to be effective in disrupting the enemy and concealing his withdrawal along covered routes to BP 40. The TM ACE CDR orders the TK PL to hold on for a few minutes longer until the 2nd PLT can complete moving to and setting up into BP 40. The TM CDR requests antitank fires from TM BLUE to cover the TK PLTs withdrawal. He is advised the smoke has made target engagement difficult, but the teams will continue to support TM ACE as best they can.

The 2nd PL reports he is in position and the TM CDR orders the TK PLT to begin withdrawing. The TK PL orders the Light Section to overwatch as the Heavy Section maneuvers to an intermediate terrain feature between BP 41 and BP 40 from which to cover the Light Section. The FIST requests heavy smoke be sustained and starts to withdraw to the same terrain feature along with the Heavy Section.

The TK PL upon arriving at the intermediate overwatching position orders the Light Section to disengage and withdraw to BP 41. TM GREEN is now providing intense antitank and artillery fires, having assumed responsibility for the engagement of the enemy as TM ACE completes the withdrawal from BP 41.

The Light Section bounds past the Heavy Section and moves to BP 40 where the TM CDR directs the Light Section into position. The TM CDR orders the TK PL to disengage and join the TM on BP 40, and the FIST and Heavy Section withdraw under the overwatching fires of TM GREEN and TM ACE. The TM CDR directs the FIST and Heavy Section into positions selected earlier and reconed by the TM executive officer.

Part IV--Narrative for Team ACE Fire Support Team (FIST)

This part of the active defense scenario describes the actions of the company fire support team (FIST) in support of each of the three platoon actions discussed previously. The FIST considered here consists of a three man headquarters element and three separate two man forward observer teams. The FIST headquarters element consists of the FIST Chief (Light Section), the fire support NCO (SSG) and the radio telephone operator (SP4). Each of the three FO teams is comprised of a forward observer (SGT) and a radio telephone operator (PFC).

The FIST operates from a modified armored personnel carrier that contains the appropriate communications equipment needed to communicate *on the three fire control nets found at the company/team level and the company/* team commander's command net. The FIST vehicle also provides the FIST with adequate protection on the battlefield and is sufficient maneuverability to move with the maneuver company/team commander. The FIST in the scenario will also make use of the digital message device and the laser location designator to interface with the artillery battalion's TACFIRE computer.

Other essential indirect fire support personnel mentioned in the scenario include the Heavy Mortar (4.2") platoon forward observed team which is co-located with the CO/TM CDR and the 81mm mortar platoon forward observer team which is colocated with the PL. The 4.2" mortar platoon FO uses the fire control net of the 4.2" mortar platoon from the Battalion/Task Force to support the CO/TM CDR when requesting indirect fire support. The 81mm mortar FO uses the fire control net of the 81mm mortar platoon of the company/team to support the PL when requesting indirect fire. The FIST FO uses the artillery fire control net to request fire support for the PL to whom he is assigned. The FIST Chief with the aid of the FS NCO coordinates all of the CO/TM indirect fire assests on behalf of the CO/TM CDR. The FIST Chief determines the priority of each call for fire, the type of weapon, the types and number of rounds, and the unit that is best suited and available to fire a particular mission. Using the digital message device, the FIST Chief transmits the calls for fire directly to the direct support artillery battery fire direction center, whenever in his judgment the 155mm weapon is best suited to fire a mission.

The decisions of the FIST Chief will be final unless the Fire Support Officer (FSO) of the maneuver Battalion Task force intervenes to cancel, modify, or redirect the call for fire from the FIST Chief. The BN/TF FSO coordinates all of the FIST Chiefs assigned to each of CO TMs of the BN/TF. The FSO is in direct contact with each of the FIST Chiefs on the artillery fire control net.

At the company/team level, the FIST Chief monitors the artillery fire control net and the command net of the CO/TM CDR he is supporting. Simultaneously, the FS NCO monitors the 81mm mortar and the 4.2" mortar platoon fire control nets. The FIST Chief will intervene on any of the fire control nets only to redirect on FOs call for fire to another fire control net when the unit requested by the FO is already engaged in another fire mission. In the event that all three fire support units available to the company/team are already fully committed when another CFF is received, the FIST Chief will contact the FSO and request he redirect the call for fire to another battery of a general support artillery battalion which will fire the mission. Figure 2.13 describes the communications nets in the FIST model.

The following fire support operations apply in the platoon action scenarios: In Platoon Action 1, "Repel an assault from a BP," the engaged platoon has company/team priority of fires. The TF CDR has delegated authority to use smoke to the BN/TF FSO who must authorize all requests for smoke missions.

In Platoon Action 3, "Disengage and occupy a new battle position," the platoon and team again have priority of fires, and the FSO delegates authority to use smoke.

Platoon Action 1, Repel an Enemy Assault from a BP

The actions of the FIST while repelling an enemy assault are detailed here. Emphasis is on the role of the forward observers in adjusting fires on acquired targets and on the FIST Chief and FS NCO in coordinating the fires requested. In the scenario, the FIST Chief has his own vehicle and sufficient radio capability to function in all required fire and command nets.

The 2nd platoon, TM ACE is ordered to repel an enemy assault from BP 41. The platoon is receiving intense suppressive fire from the advancing enemy motorized forces as they push toward the BP. The PL orders the first squad to move into a covered and concealed blocking position on the left flank of the advancing enemy column, while the overwatching squads and the weapons squad return fire to suppress the enemy fire. To blunt the enemy penetration, the PL orders the FIST FO to call for TGP 1 which consists of three preplanned target reference points along the enemy avenue of approach. He instructs the 81mm FO to be prepared to call for fire on any enemy infantrymen that dismount to suppress friendly antitank fire.

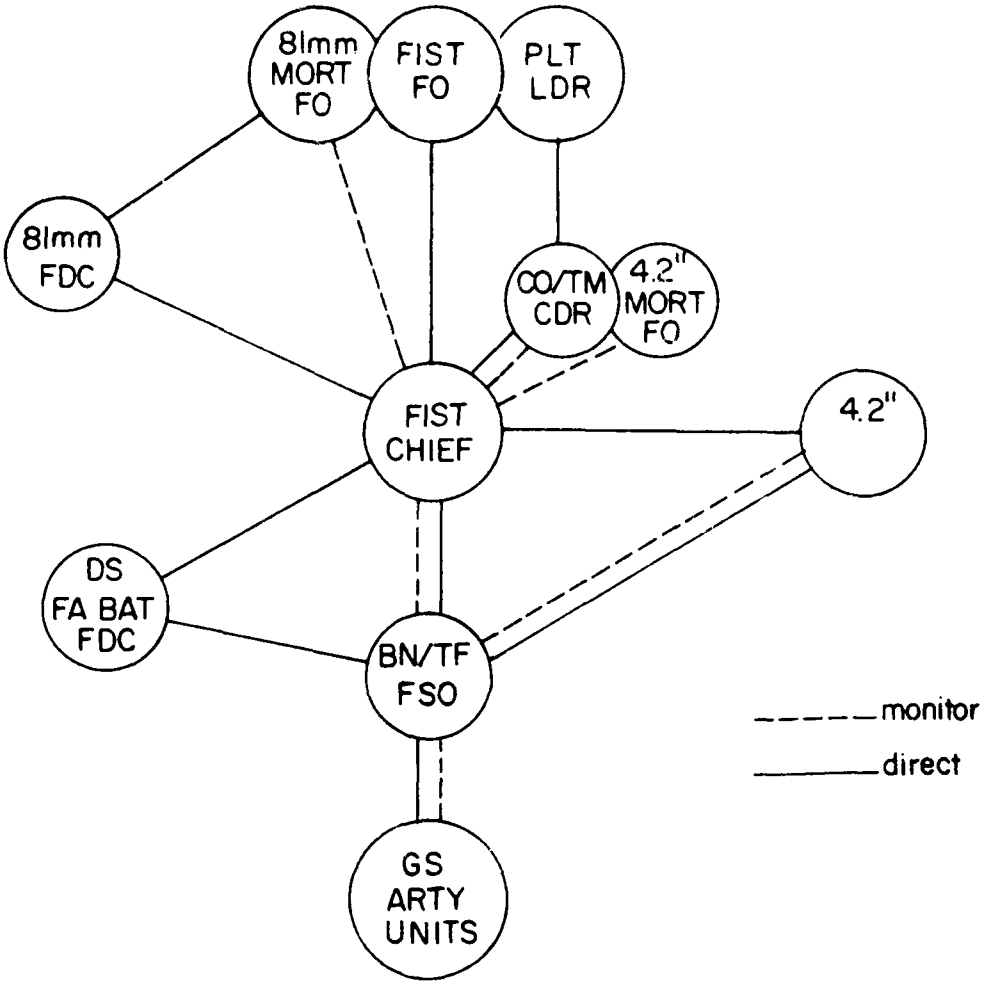


Figure 2.13. Communications nets in FIST model which are available to request indirect fire.

The FIST FO immediately requests immediate suppression of TGP 1 using the artillery fire control net. The FIST Chief monitoring the call, contacts the BN/TF FSO to get permission to fire the target group. The FSO approves and directs the direct support artillery battery to fire the target group at his command. While this is taking place, the PL orders his MAW crews to engage the lead tanks with crossing fire. The 155mm HE/VT rounds impact on the three target reference points of the target group exploding among the BMPs following the enemy tanks. This intense fire momentarily disrupts the enemy's coordinated advance, separating the tanks from the BMPs. Two BMPs are immobilized by the artillery fire and the PL orders two carrier gunners to destroy the disabled BMPs with CAL/50 fire. Two carriers move forward from reverse slope positions into hull defilade, engage the BMPs, and destroy both. The MAW gunners, firing as the artillery rounds impacted, destroy two tanks. The First SQD opens fire from the flank with light antitank weapons and disables another BMP.

Enemy infantrymen begin to dismount to suppress the friendly AT Fire. The PL orders the MAW gunners to move to alternate positions. The PL and FOs "button up" and move to another observation position as intense enemy suppressive fires close in on them. The PL, while on the move, orders the carrier gunners and the M60 gunners to engage the dismounted infantry. Monitoring the CO/TM net, the FIST Chief realizes the 2nd PLT is temporarily without indirect fire support as the PL and FOs relocate. Having positioned himself where he can observe the 2nd PLTs situation, the FIST Chief uses the laser designator to track an enemy tank and requests destruction Fire with CLGP. He also directs the 4.2" mortars to shift fire from TRP 2 (one of the TRPs of the original target group) to hit enemy infantrymen dismounting from the BMPs. The CLGP destroys the designated tank and the mortar Fire kills several exposed infantrymen.

The PL reports to the TM CDR that he is in position again and the two FOs report their new location to their respective FDCs. The enemy tanks, separated from the dismounted infantry and slowed by the trees are receiving intense antitank fire from squad LAWs. The enemy infantryman supported by the BMPs which have now taken up defilade positions are moving rapidly again to close the gap with their tanks. The PL orders the MAW gunners to engage the remaining tanks and requests the TM CDR have the FIST engage tanks with CLGP. The FIST FO requests a shift from TRP 3 to engage a BMP in defilade, while the 81mm FO requests a shift from TRP 2 to engage dismounted infantry closing with the enemy tanks. The PL requests the 4.2" mortars fire TRP 1 to engage another group of dismounted infantrymen.

The FIST monitoring the PLs requests immediately uses the laser designator and requests CLGP to engage a tank. He also redirects the PLs request for the 4.2" mortar platoon to fire TRP 1 to the FSO, because the 4.2" mortars are already firing a mission for the 1st PLT. The FS NCO monitors the 81mm call for fire. All fires are effective.

The Task Force Commander directs the FSO to place smoke on overwatching enemy antitank positions immediately. The FSO instructs the FIST Chiefs to have all FOs adjust smoke on known or suspected enemy antitank positions.

The FIST FO informs the PL of the TF CDR's order and requests smoke in effect on observed enemy weapons signatures in overwatching positions.

The PL receives a situation report from 1st SL saying that large numbers of enemy vehicles are attempting to bypass the kill zone by maneuvering to the west. The PL requests TRP 5 be fired in order to rechannel the enemy column into the kill zone. The FIST Chief redirects this request to the FSO who sends it to the GS artillery unit. Artillery fire on TRP 5 effectively rechannels the enemy into the kill zone of 2nd platoon. Without effective antitank overwatching fires, the enemy press forward with heavy losses from friendly antitank fires. Infantry attempting to dismount are immediately engaged by machine guns and mortars. However, the enemy is able to close within 300m and could still make a penetration. The PL orders the 81mm FO to call for the FPF, requests TM CDR fire 4.2" FPF in the platoon defensive sector and requests the artillery again fire TG 3. The FIST Chief monitors the requests, redirects the TG 3 request to the FSO for GS artillery to fire, informs the FSO of TM CDRs decision to fire 4.2" FPF and of the PL's call for 81mm FPF.

These intense, continuous, final protective fires completely break up the enemy formation forcing the surviving elements to attempt to withdraw. Observing the withdrawal the PL requests the FPF be ended, and orders the FOs to engage disabled vehicles with destruction fire and the withdrawing enemy infantry with area fires until no targets can be observed.

Platoon Action 2, Create and Defend a Strongpoint

The role of the FIST in preparing to defend a battle position is to select observation posts, select target reference points, and prepare a fire plan that supports the team commanders concept of the defense. In addition, the FIST Chief will advise the Team CDR, as will the FOs and the PLs in how to make use of organic suppressive fires in order to free the indirect fires for other targets.

Throughout the time the platoon is preparing the defensive strong point. The FIST and the artillery FOs are continuously engaged in fire planning activities. The artillery FO and the 81mm FO prepare terrain sketches of the strongpoint area and report the coordinates of the observation posts from which they will be adjusting indirect fire to their respective FDCs. The FIST Chief and FS NCO monitor and record this information for future reference. The

PL orders the artillery FO to plan the antiarmor fire plan and the 81mm FO to plan the antipersonnel fire plan. Each FO selects only readily identifiable terrain features, likely avenues of approach and known or suspected enemy locations. Targets are planned on top of the strongpoint and behind it. Each FO transmits his essential target list to the FDC using a secure means. The FIST Chief and FS NCO monitor and record these target lists for future use. Each FDC compiles the target lists of its FOs and submit the list to the FSO who eliminates duplications, assigns unique target numbers, and provides the FDCs and FOs with a composite list of the assigned target numbers for each weapons system.

Based on the PLs and the team commander's defensive plan, the FIST Chief and the FOs plan targets which will require special adjustment of individual weapons to achieve the desired dispersal of rounds at the target. The FO adjusts the individual weapons and the sight and gun data for each are recorded for each special target by the FDC and the FIST. In coordination with the CO/TM CDR and the PLs, the FIST also groups targets to provide intense prearranged fires. The FIST orders that the method of control for such fires will be "on call" or "at his command" whichever seems appropriately to support the company level maneuver leaders. The FIST insures wire communications are established with the artillery FO in the strongpoint at each proposed observation post. The FIST coordinates with the TM CP to insure the preplanned fires support the CO/TM commanders barrier plan. Areas where artillery delivered scatterable mines might be required are planned for.

Platoon Action 3, Disengage and Occupy a New BP

The FIST plays a crucial role during disengagement and withdrawal. Prior fire planning makes the job easier. However, adjusting supporting fires to block an advancing enemy must still be accomplished even when moving away from the enemy. Artillery support must be continuous and flexible to support the withdrawal. The actions of the FIST are described in this part of the scenario.

The CDR of TM ACE orders the 2nd PL to disengage and move from BP 41 to occupy BP 40. The 81mm mortar FO adjusts continuous mortar fire on the dismounted infantry. The FIST FO and the FIST engage enemy BMPs with CLGP. The FS NCO also adjusts 4.2" mortar fire on enemy infantry. As this intense indirect fire temporarily disrupts the enemy's coordinated advance, the PL orders the 1st squad to remount in the predesignated PLT assembly area. Immediately, the 1st squad's carrier moves to the assembly area using a covered and concealed route and the dismounted squad members remount the carrier. The SL reports to the PL that he is ready to move to BP 40. The PL instructs the 2nd squad to remount in the designated assembly area. Throughout the FOs and FIST continue to engage both enemy infantry and BMPs. The PL requests that the TM CDR have the tank PLT and HAWs cover the disengagement of his 3rd squad and PLT antitank weapons. The FIST monitoring

the CO/TM command net realizes the FIST FO and 81mm FO will be unable to adjust fires while moving and orders the FS NCO to adjust both the 81mm mortar and the 4.2" mortar fire while he adjusts both DS and GS artillery to maintain continuous intense indirect fire. The TK PLT and HAWs engage enemy BMPs and tanks as the 2nd platoon withdraws from BP 41 and moves by covered routes to BP 40. Immediately upon arrival at BP 40, the FOs begin fire planning in preparation for defense of the new BP.

Part V--Narrative for 155mm Direct Support Artillery Battery

The actions of the howitzer crews and the key howitzer battery leaders are described in this part of the scenario. The FDC and forward observer personnel actions have been omitted. Attention is focused only on those involved directly with the laying, loading, and firing of the cannon themselves. The scenario describes three different situations.

At the outset, the battery is called on to support a unit under attack (medium demand). Next the battery is firing in support of a unit that is preparing a defensive position (low demand). Finally, continuing to fire in support of a maneuver unit under attack, the Howitzer section is itself forced to displace to avoid the effects of counter battery fires (heavy demand). The notion of platoon actions are not appropriate with respect to the battery. Therefore, these three parallel battery actions are presented.

The direct support artillery battery commander orders the battery executive officer to occupy a firing position to support the task force. The battery XO with guides and the gunnery sergeant moves to position. There, the XO selects exact gun positions while the gunnery sergeant sets up the aiming circle and declinates it. The XO orders the battery to displace by echelon. When the first guns and ammunition carriers arrive at the firing position the guides indicate the position for each and the general direction of fire. The XO immediately begins laying the sections on the FDC determined direction of fire using the aiming circle. Announcing deflections for each cannon gunner. The XO lays each gun and announces the measurement to the crest (minimum elevation for guns). Crew members place out the aiming posts and the gunners acquire sight picture for later reference. Simultaneously the ammunition carriers are readying ammunition for immediate use. When the first echelon is laid, the XO orders the second echelon and FDC to displace and move to the new firing positions. When the second echelon arrives, these guns are laid in the same manner as the first.

Communications personnel lay wire between the guns and the FDC. The XO renders his report to the FDC as soon as the sections are all ready.

CHAPTER III

MECHANIZED INFANTRY PERFORMANCE

Projected performance degradation in mechanized infantry duty positions, squads, and platoons are summarized. Detailed projections by tasks and defensive (platoon) actions are tabulated. Digests of adverse factors' impacts on 76 critical tasks are provided.

Summary of Continuous Operations Effects

Of the four debilitating factors considered here, fatigue (sleep loss over five days), light level (visibility), stress, and disruption of diurnal rhythms, fatigue is expected to produce the greatest performance decrement among infantry personnel. However, all tasks performed by infantry personnel are not affected uniformly. While tasks that have a heavy cognitive or vigilance component are expected to degrade in proportion to the amount of sleep lost, performance of motor tasks that are well practiced or routine is likely to deteriorate very little with increasing sleep loss over the first three days. Cognitive (mental) and perceptual tasks most severely affected by sleep loss are encoding/decoding, logical reasoning, and accurate perception/concentration. Simple, as opposed to complex motor tasks, differ in their ability to resist performance decrements. Such tasks can be distinguished by the following example. While loading a weapon's magazine can be expected to show little deterioration with sleep loss, a fine motor task such as stripping and assembling a rifle can be expected to deteriorate somewhat. Apparently, routine motor tasks are extremely resistant to sleep loss. Even acutely sleep-deprived soldiers can be expected to maintain their ability to march across country. However, their SL may not be able to use a map effectively to orient the squad.

Soldiers cannot be expected to function well as fighting men for more than two days without sleep. However, even totally sleep deprived soldiers can be expected to satisfactorily perform routine motor tasks for as long as five days.

In contrast, most cognitive and vigilance based tasks can be expected to begin to deteriorate somewhat after the very first day of sleep loss and significantly after 36-48 hours. Extreme environmental conditions such as heat, cold, humidity, or noise can be expected to hasten the inevitable performance decrement. A summary of projected effectiveness of various positions of the mechanized infantry over 120 hours (5 days) of continuous combat operations with little or no organized sleep appears as Figure 3.1. The index of effectiveness (E) lies between 0 and 100 (actually 0 and 1.00). An E-value

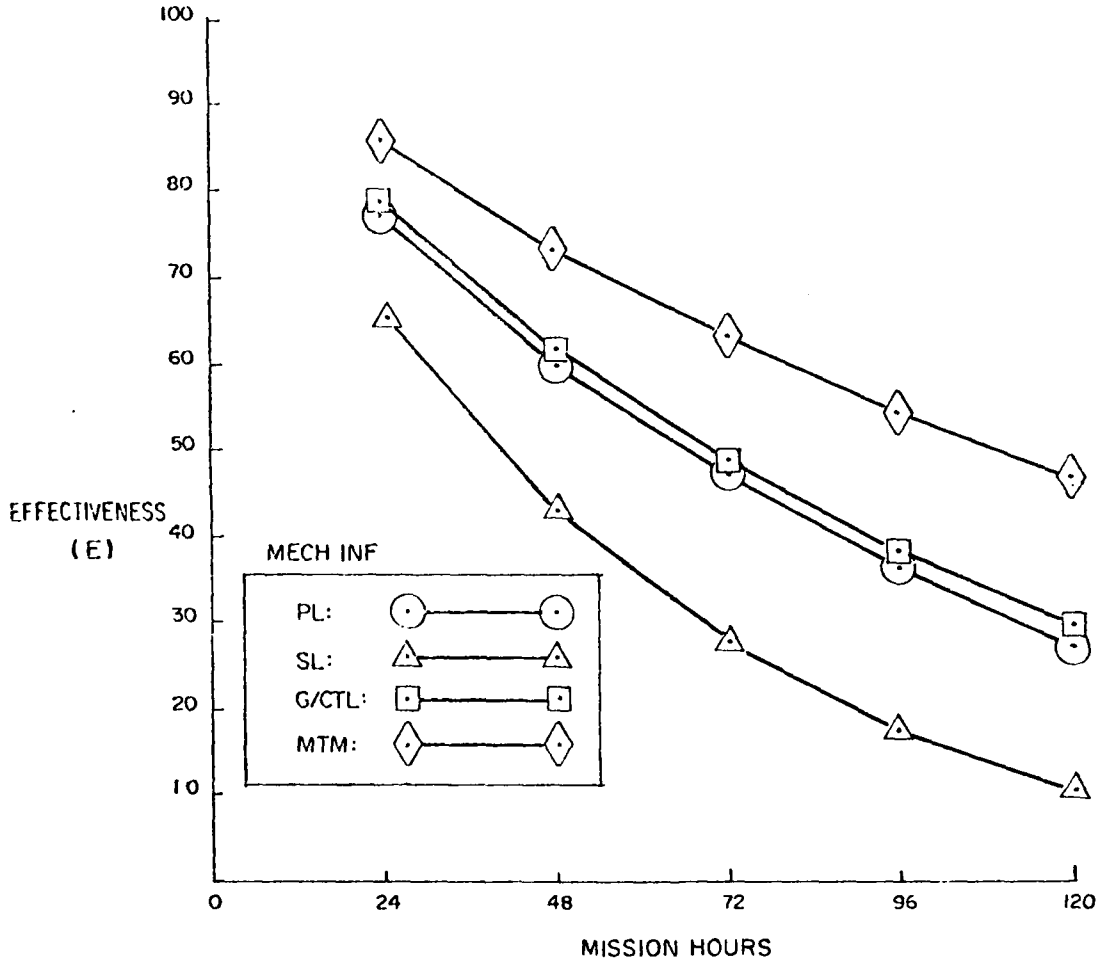


Figure 3.1. Performance degradation in mechanized infantry positions (PL = Platoon Leader, SL = Squad Leader, G/CTL = Gunner/Carrier Team Leader, MTM = Maneuver Team Member).

of 100 represents normal, routine effectiveness of performance evident, perhaps, in training exercises; a value of 0 represents performance that is no longer militarily useful, but does not imply an absence of any and all activity.

The infantry duty position expected to degrade most rapidly is that of the SL, whose responsiblities (tasks) include a heavy cognitive component. Degraded least is the position of MTM, whose tasks are more of a simple motor type and well practiced or routine.

Figure 3.2 presents forecasted effectiveness as a function of mission duration for the mechanized infantry Squad and Platoon. The graph illustrates that the Squad degrades more rapidly than the Platoon as a whole. Effectiveness of the Squad under the "best" (no degrading conditions other than sleep loss) and the "worst" (all potential impacts affecting all relevant abilities) conditions of debilitating factors is presented as Figure 3.3. The graph illustrates that the influence of debilitating factors (light level, stress, diurnal rhythms) is less than the influence of mission duration (sleep loss) in degrading performance effectiveness. Manning considerations can also affect performance.

Table 3.1 presents the projected overall (summarized) effectiveness of mechanized infantry Duty Positions, Squads, and Platoons for different platoon actions and mission days (sleep loss). The results indicate that wide variations in performance can be expected for different positions and platoon actions. Best and worst performance ranges between very effective, e.g., .90, and grossly ineffective, e.g., .09, over five days.

Table 3.1

Effectiveness (E) of Mechanized Infantry: Duty Positions, Squads, and Platoons in Different Platoon Actions and Over Mission Days

		Duty Position				Infantry	
	Day	PL	SL	MTM	GR	Squad	Platoon
Platoon Action 1	1	88	55	92	69	72	89
	3	69	17	77	32	38	71
	5	54	5	65	15	20	56
Platoon Action 2	1	88	74	86	77	83	91
	3	67	41	65	46	56	74
	5	51	23	48	28	38	61
Platoon Action 3	1	62	71	81	93	86	76
	3	23	36	52	81	63	45
	5	9	18	34	70	45	26
Platoon Action 1,2,3	1	78	66	86	79	80	85
	3	48	29	64	49	51	62
	5	29	13	47	31	32	45

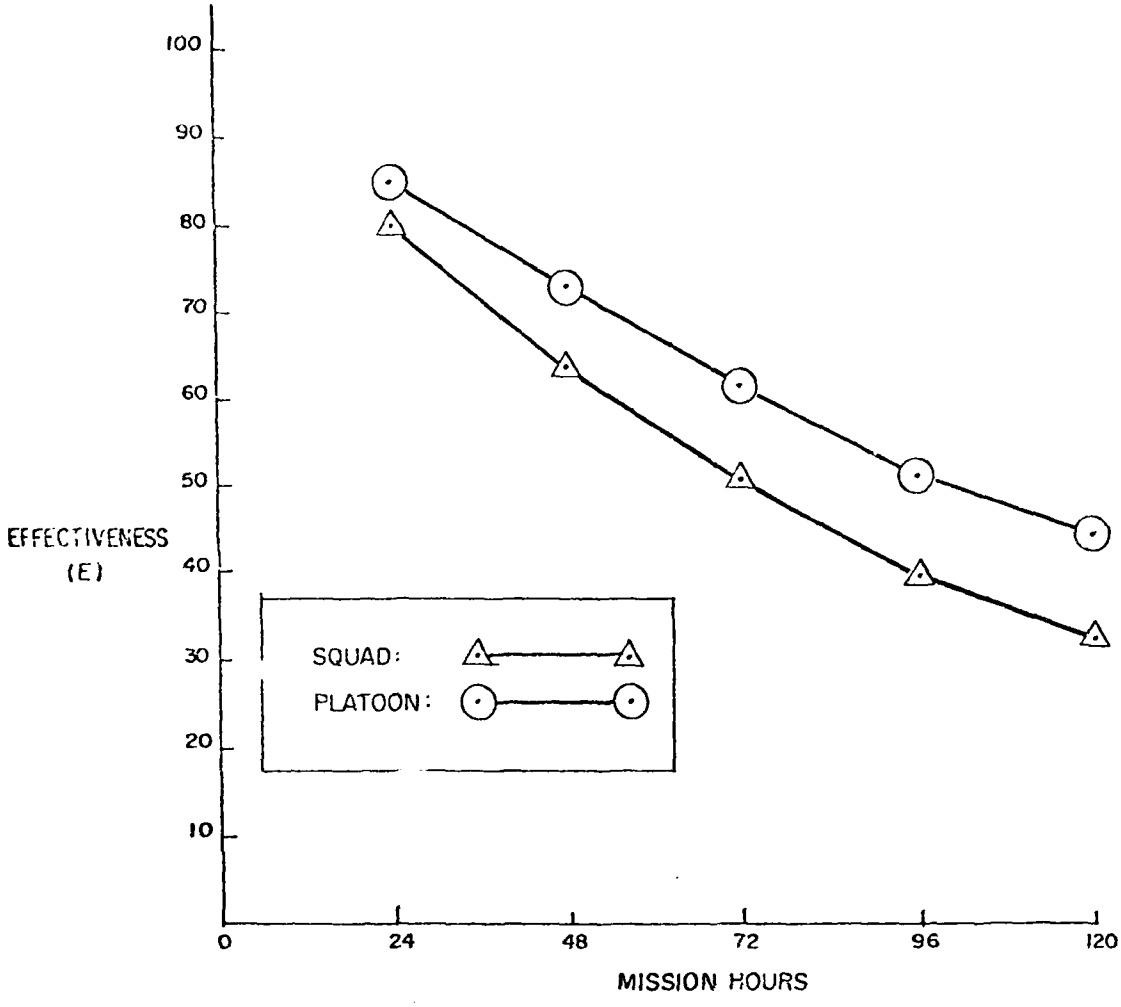


Figure 3.2. Performance degradation in mechanized infantry squads and platoons with all adverse factors present.

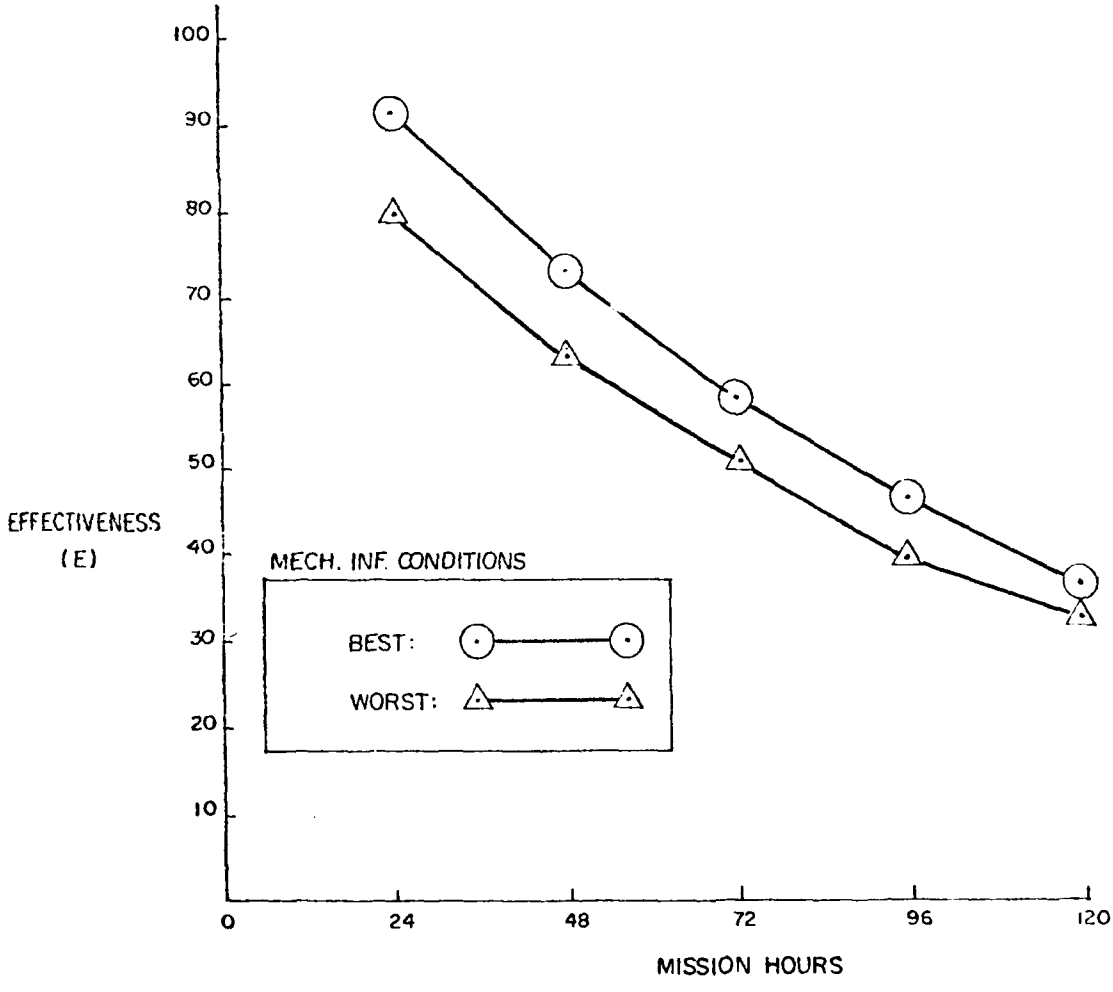


Figure 3.3. Projected performance degradation of mechanized infantry squads under "best" and "worst" conditions.

Table 3.2 presents the effectiveness of mechanized infantry Duty Positions, Squad, and Platoons as a function of impacting (debilitating) factors. While a mechanized infantry platoon normally consists of four squads, a somewhat understrength condition of only three squads per platoon was assumed for the calculation of the effectiveness (E) values shown in Tables 3.1 and 3.2. Since the scenario (Chapter II) assumed 6 to 1 odds, this seemed to be a realistic assumption for mechanized infantry function. Similarly, a Squad was assumed to consist of only six members: a Squad Leader (SL), a Gunner and Carrier Team Leader (G/CTL), and four Maneuver Team Members (MTMs). A full strength squad consists of eleven men. In Table 3.2, impacting factors are coded as follows:

F = Fatigue level in mission hours (24-120)

L = Light level: 1 = dark and 0 = light

S = Stress: 1 = stress present and 0 = stress absent

D = Diurnal rhythm: 1 = rhythm out of phase and
0 = rhythm in phase.

The tabled values suggest that fatigue (sleep loss over mission hours) is more important in degrading performance over five days than any of the other factors. This corresponds to uniform experience whether from informal observation or scientific study. Note that fatigue (sleep loss) levels are considered over five days (120 hours) of mission duration, whereas all other factors are binary (present or absent).

Also note that values of E (the effectiveness index) in Table 3.2 represent all possible degrees or combinations in the impact of the debilitating factors on performance. The least degradation occurs with the 24, 0, 0, 0 combination of debilitating factors, and the greatest degradation with 120, 1, 1, 1. Intermediate conditions lie between these extremes. The E-values shown in Table 3.2 represent the indicated hour, i.e., the last hour of the first, second, third, fourth, and fifth days of continuous combat operations.

Table 3.3 presents the projected effectiveness (E) for each critical combat tasks performed by the several duty positions of the mechanized infantry. Successive parts of Table 3.3 present projected values of E for tasks performed by the G/CTL, MTM, SL, and PL. Values of E are tabled for each of the three types of platoon actions (1, 2, and 3) and for the average across the three types (Platoon Actions 1, 2, 3). In each case values are given for the (last hour of) first, second, third, fourth, and fifth day of continuous combat operations.

What most characterizes the pattern of projected values is the variability of effectiveness across tasks and platoon actions. While some tasks are degraded only nominally over five days (120 hours) of continuous operations, others are projected to become very quickly degraded to unacceptable levels. An example of a task degraded only nominally is No. 27 (firing at

Table 3.2

Summarized Effectiveness (E) of Mechanized Infantry: Duty Positions, Squads, and Platoons under all Combinations of Adverse Conditions

Impacting Debilitating Factors				Duty Position				Infantry	
F	L	S	D	PL	SL	MTM	GR	Squad	Platoon
24	0	0	0	93	85	94	92	92	95
24	0	0	1	89	79	94	90	89	93
24	0	1	0	86	78	91	87	87	91
24	1	0	0	88	78	90	86	87	92
24	0	1	1	82	73	90	85	85	88
24	1	0	1	85	73	89	83	84	90
24	1	1	0	82	71	87	81	82	88
24	1	1	1	78	66	86	79	80	85
48	0	0	0	72	56	81	73	73	81
48	0	0	1	69	53	81	71	71	79
48	0	1	0	67	52	78	69	70	77
48	1	0	0	69	52	77	68	69	78
48	0	1	1	64	48	78	68	68	75
48	1	0	1	66	48	77	66	67	76
48	1	1	0	64	47	74	65	66	75
48	1	1	1	61	44	74	63	64	73
72	0	0	0	57	37	70	57	58	69
72	0	0	1	54	35	70	56	57	67
72	0	1	0	53	34	69	54	55	66
72	1	0	0	54	34	68	53	55	67
72	0	1	1	51	32	67	53	54	65
72	1	0	1	52	32	66	52	54	65
72	1	1	0	50	31	65	50	52	63
72	1	1	1	48	29	64	49	51	62
96	0	0	0	44	25	60	45	47	59
96	0	0	1	42	23	60	44	45	57
96	0	1	0	41	23	58	43	45	56
96	1	0	0	42	23	58	42	44	57
96	0	1	1	39	21	58	42	43	54
96	1	0	1	40	21	57	41	43	55
96	1	1	0	39	21	55	40	42	54
96	1	1	1	37	19	55	39	40	52
120	0	0	0	34	16	52	36	37	49
120	0	0	1	33	15	51	35	36	49
120	0	1	0	32	15	50	34	36	48
120	1	0	0	33	15	49	34	35	48
120	0	1	1	31	14	50	33	34	47
120	1	0	1	31	14	49	33	34	47
120	1	1	0	30	14	47	32	34	46
120	1	1	1	29	13	47	31	32	45

Table 3.3

Projected Effectiveness (E) for Critical Combat Tasks: Mechanized Infantry

Gunner/Carrier Team Leader

		Task No.																
	Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Platoon Action$_1$	1	61	62	67	78	100	57	78	92	73	71	36	51	57	41	100	100	92
	2	37	39	46	61	100	32	61	84	53	51	13	27	32	17	100	100	84
	3	23	24	31	48	100	18	48	78	38	36	05	14	18	07	100	100	78
	4	14	15	21	37	100	10	37	71	28	26	02	07	10	03	100	100	71
	5	08	09	14	29	100	06	29	65	20	18	01	04	06	01	100	100	65
Platoon Action$_2$	1	61	67	100	100	100	92	84	92	73	85	46	78	85	57	73	55	100
	2	37	46	100	100	100	84	71	84	53	73	21	61	73	32	53	30	100
	3	23	31	100	100	100	78	59	78	38	62	10	48	62	18	38	17	100
	4	14	21	100	100	100	71	50	71	28	53	04	37	53	10	28	09	100
	5	08	14	100	100	100	65	42	65	20	45	02	29	45	06	20	05	100
Platoon Action$_3$	1	100	100	100	100	100	57	78	92	73	100	100	100	100	100	100	100	100
	2	100	100	100	100	100	32	61	84	53	100	100	100	100	100	100	100	100
	3	100	100	100	100	100	18	48	78	38	100	100	100	100	100	100	100	100
	4	100	100	100	100	100	10	37	71	28	100	100	100	100	100	100	100	100
	5	100	100	100	100	100	06	29	65	20	100	100	100	100	100	100	100	100
Platoon Actions 1, 2, 3	1	72	75	87	92	100	67	80	92	73	85	55	74	79	61	90	82	97
	2	52	56	76	85	100	45	64	84	53	72	30	55	62	38	81	67	95
	3	37	42	67	78	100	30	51	78	38	61	17	40	49	23	73	55	92
	4	27	32	58	72	100	20	41	71	28	52	09	30	38	14	65	45	89
	5	19	24	51	66	100	13	33	65	20	44	05	22	30	09	59	37	87

NOTE: A value of 100 after the second day implies that only NOMINAL DEGRADATION will occur after that day.

A value of 00 is to be interpreted as E < 1 (i.e., very low).

Table 3.3 (cont.)

Maneuver Team Member

Task No.

	Day	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Platoon Action$_1$	1	78	100	78	100	100	100	100	78	100	100	100	100	57	100	100
	2	61	100	61	100	100	100	100	61	100	100	100	100	32	100	100
	3	48	100	48	100	100	100	100	48	100	100	100	100	18	100	100
	4	37	100	37	100	100	100	100	37	100	100	100	100	10	100	100
	5	29	100	29	100	100	100	100	29	100	100	100	100	06	100	100
Platoon Action$_2$	1	85	73	78	85	67	100	100	86	62	100	74	100	100	100	100
	2	73	53	61	73	46	100	100	74	39	100	54	100	100	100	100
	3	62	38	48	62	31	100	100	63	24	100	40	100	100	100	100
	4	53	28	37	53	21	100	100	54	15	100	29	100	100	100	100
	5	45	20	29	45	14	100	100	47	09	100	22	100	100	100	100
Platoon Action$_3$	1	100	56	78	65	100	85	67	60	100	100	100	73	100	85	62
	2	100	32	61	43	100	73	46	37	100	100	100	53	100	73	38
	3	100	18	48	28	100	62	31	22	100	100	100	38	100	62	23
	4	100	10	37	18	100	53	21	13	100	100	100	28	100	53	14
	5	100	06	29	12	100	45	14	08	100	100	100	20	100	45	09
Platoon Actions 1, 2, 3	1	88	74	78	83	88	95	88	74	85	100	90	90	83	95	85
	2	77	55	61	68	77	90	77	55	73	100	82	81	69	90	72
	3	67	41	48	56	67	86	67	41	62	100	74	73	57	86	62
	4	59	30	37	47	59	82	59	30	53	100	67	65	47	82	52
	5	52	23	29	38	52	78	52	22	46	100	60	59	39	78	45

Table 3.3 (cont.)

Squad Leader

Task No.

	Day	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Platoon Action$_1$	1	100	100	100	100	100	100	26	61	31	51	62	26	71	100	100	100	100
	2	100	100	100	100	100	100	07	37	10	26	39	07	51	100	100	100	100
	3	100	100	100	100	100	100	02	23	03	13	24	02	36	100	100	100	100
	4	100	100	100	100	100	100	00	14	01	07	15	00	26	100	100	100	100
	5	100	100	100	100	100	100	00	08	00	03	09	00	18	100	100	100	100
Platoon Action$_2$	1	100	100	100	67	73	85	67	61	46	67	78	31	78	66	100	100	100
	2	100	100	100	44	53	73	46	37	22	46	61	10	61	44	100	100	100
	3	100	100	100	29	38	62	31	23	10	31	48	03	48	29	100	100	100
	4	100	100	100	20	28	53	21	14	05	21	37	01	37	19	100	100	100
	5	100	100	100	13	20	45	14	08	02	14	29	00	29	13	100	100	100
Platoon Action$_3$	1	61	78	67	45	46	100	26	46	41	92	52	26	71	100	41	73	51
	2	37	61	45	21	22	100	07	21	17	84	27	07	51	100	17	53	26
	3	23	48	30	09	10	100	02	10	07	78	14	02	36	100	07	38	13
	4	14	37	20	04	05	100	00	04	03	71	07	00	26	100	03	28	07
	5	08	29	13	02	02	100	00	02	01	65	04	00	18	100	01	20	03
Platoon Actions 1, 2, 3	1	85	92	87	67	70	95	36	55	39	68	63	28	74	87	74	90	80
	2	72	85	76	45	49	90	13	31	15	46	40	08	54	76	55	81	64
	3	61	78	67	30	34	85	05	17	06	32	25	02	40	66	41	73	51
	4	52	72	58	20	24	81	02	09	02	21	16	01	29	57	31	65	41
	5	44	66	51	14	16	77	01	05	01	15	10	00	22	50	23	59	32

Table 3.3 (cont.)

Platoon Leader

Task No.

	Day	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66
Platoon Action$_1$	1	100	100	100	100	100	100	56	67	100	84	100	67	92	100	100	100	84
	2	100	100	100	100	100	100	32	46	100	71	100	45	84	100	100	100	71
	3	100	100	100	100	100	100	18	31	100	59	100	30	78	100	100	100	59
	4	100	100	100	100	100	100	10	21	100	50	100	20	71	100	100	100	50
	5	100	100	100	100	100	100	06	14	100	42	100	13	65	100	100	100	42
Platoon Action$_2$	1	67	85	100	78	47	100	61	78	100	92	78	100	100	100	78	100	100
	2	46	73	100	61	22	100	37	61	100	84	61	100	100	100	61	100	100
	3	31	62	100	48	10	100	23	48	100	78	48	100	100	100	48	100	100
	4	21	53	100	37	05	100	14	37	100	71	37	100	100	100	37	100	100
	5	14	45	100	29	02	100	08	29	100	65	29	100	100	100	29	100	100
Platoon Action$_3$	1	67	73	92	71	32	92	49	56	71	78	36	56	92	42	56	91	77
	2	46	53	84	51	10	84	25	32	51	61	13	31	84	18	31	82	59
	3	31	38	78	36	03	78	12	18	36	48	05	17	78	07	17	75	45
	4	21	28	71	26	01	71	06	10	26	37	02	10	71	03	10	68	35
	5	14	20	65	18	00	65	03	06	18	29	01	05	65	01	05	61	27
Platoon Actions 1, 2, 3	1	77	85	97	82	53	97	56	67	89	85	66	72	94	75	76	97	86
	2	59	73	95	68	28	95	31	45	80	72	43	52	89	56	57	94	75
	3	46	62	92	56	15	92	17	30	71	60	28	37	84	42	43	91	65
	4	35	53	89	46	08	89	10	20	64	51	19	27	80	31	33	88	56
	5	27	45	87	38	04	87	05	13	57	43	12	19	75	23	25	85	48

Table 3.3 (cont.)

Platoon Leader (cont.)

Task No.

	Day	67	68	69	70	71	72	73	74	75	76
Platoon	1	100	52	42	100	100	100	100	100	100	100
	2	100	27	18	100	100	100	100	100	100	100
	3	100	14	07	100	100	100	100	100	100	100
	4	100	07	03	100	100	100	100	100	100	100
	5	100	04	01	100	100	100	100	100	100	100
Platoon $Action_2$	1	100	100	67	100	100	100	100	100	100	72
	2	100	100	46	100	100	100	100	100	100	52
	3	100	100	31	100	100	100	100	100	100	37
	4	100	100	21	100	100	100	100	100	100	27
	5	100	100	14	100	100	100	100	100	100	19
Platoon $Action_3$	1	92	41	36	92	57	61	41	60	78	56
	2	84	17	13	84	32	37	17	37	61	31
	3	78	07	05	78	18	23	07	22	48	17
	4	71	03	02	71	10	14	03	13	37	10
	5	65	01	01	65	06	08	01	08	29	05
Platoon Actions 1, 2, 3	1	97	60	47	97	83	85	74	85	92	74
	2	95	36	22	95	69	72	55	72	85	54
	3	92	22	10	92	57	61	41	60	78	40
	4	89	13	05	89	47	52	31	51	72	29
	5	87	08	02	87	39	44	23	43	66	22

areas). A MTM usually performs this task. An example of a task quickly degraded to an unacceptable level under the impact of adverse factors is No. 41 (directing relocation fire). This task is usually performed by the SL.

Table 3.4 presents the debilitating factors which impact the critical abilities for each critical task in each platoon action. The table heading shows the abilities (see Taxonomy in Chapter I) needed for task performance and the debilitating factors (see Chapter I) impacting on these abilities. In the body of the table, only the impacts are recorded. That is, the absence of an entry may be due to the fact that: (a) the task in question is not critical in the given platoon action, (b) the ability in question is not critical for the given task, or (c) the ability in question is not depressed in this task and platoon action. Where there is an entry in the table, a "1" denotes a significant (greater than 20%) depression of the ability in Platoon Action 1, a "2" denotes the same for Platoon Action 2, and a "3" for Platoon Action 3.

As well as a descriptive summary of adversely affected critical abilities in critical tasks, Table 3.4 serves as a cross-index. The following information can be obtained from the cross-index:

a. critical tasks performed by various duty positions

b. source(s) of adverse impacts on critical abilities

c. adversely affected (depressed) critical abilities in critical tasks

d. adversely affected tasks in platoon actions

e. combinations of the above.

Accordingly, the cross-index can be used to answer various questions, such as:

- who performs a given task?
- which critical abilities are depressed in which task and which platoon action?
- which conditions (debilitating factors) determine decrements in which critical ability(ies)?
- which tasks experience parallel patterns of degradation?

Underlying Table 3.4 is the premise that a set of relationships governs the depressive effect of the debilitating factors on the various critical abilities.

Table 3.4

Mechanized Infantry: Summary of Significant Depressions of Critical Abilities

	TASK NO.	FATIGUE						DIURNAL RHYTHM		LIGHT LEVEL				STRESS			
		V	H	NF	R	PS	O	NF	R	V	H	DP	O	M	R	PS	C
GUNNER/	1	12	17			12				12	12					12	
CARRIER	2	12				12				12	12		12				
TEAM	3	1				1				1	1					1	
LEADER	4	1								1	1						
	5																
	6	3	1 3			1 3	1 3			123	1 3	1 3		1 3		1 3	
	7						123						123	1 3			
	8																123
	9	123	123			123				123							
	10			12	12				1						1		
	11			12	12	1	12	12	12	12			12	1	12	12	
	12			1	1				12	12	1			1	1		12
	13						1	1	1	12			12		1		1
	14	12	12	1	1	12		12	12	12					1	12	
	15						2						2	2	2		
	16	2		2	2			2	2	2					2		
	17																
MANEUVER	18									12		12			1		
TEAM	19	23	23			23				23	23			3		3	
MEMBER	20	123								123		123					
	21			23	23			3	3						3		
	22		2				2				2	2		2			2
	23						3			3		3					
	24						3			3			3	3		3	
	25			123	123			3	3					3	1 3		
	26	2	2			2				2				2		2	
	27																
	28	2				2								2		2	
	29					3				3			3			3	
	30	1	1			1				1		1		1		1	
	31									3			3				
	32	3	3			3				3				3		3	
SQUAD	33	3	3			3				3	3					3	
LEADER	34				3										3		3
	35	3					3			3			3				
	36	23		23	23		23	3	3	3			23		3		
	37	3		23	23		23	3	3	3			23				
	38			2	2												
	39	123	123	1 3	1 3	1 3		123	123	123	1 3			1 3	1 3	1 3	1 3
	40			123	123		123	123	123				123	3	3		3
	41	123	123	123	123		12	123	123	123	1 3		12		1 3		
	42	1 3		12	12		12	1	1	12			12				
	43		123				123	3	3				123	1 3	1 3		1 3
	44	123	123	123	123	123		123	123	123	123			123	123	123	1 3
	45			123	123				1 3						123		
	46			2	2				2						2		2
	47		3	3	3		3		3	3	3		3		3		3
	48		3							3	3						3
	49			3	3		3		3			3		3	3		3
PLATOON	50						23	23	23	23			23				
LEADER	51						3			23			23			3	
	52																
	53			23	23				23						3		
	54		23	23	23	3		3	23	23	23			23	23	23	23
	55																3
	56			123	123		1 3	1 3	123				123	123	123		
	57			123	123	1 3			1 3	1 3					123		3
	58			3	3				3						3		
	59						1 3						123				
	60	3		3	23	3	3		3				23	3	3	3	
	61			1 3	1 3			1 3	1 3				3		3		1 3
	62																1 3
	63			3	3			3	3	3	3		3	3	3		3
	64			3	3		23		23				23		3		3
	65																3
	66				1 3				1 3						3		
	67																3
	68		1 3	1 3	1 3			3	1 3	1 3	1 3			1	1 3		1 3
	69			1 3	1 3	1 3	123	1 3	1 3				123	12	123	123	1 3
	70																3
	71	3	3										3	3			3
	72				3			3	3	3	3			3	3		3
	73	3	3		3	3			3					3	3		3
	74				3		3		3	3	3		3		3		3
	75						3						3				3
	76			3	3		23		23				23		23		3

The relation between debilitating factors and the critical abilities on which they act is summarized in Table 3.5. Table 3.5 suggests that each of these factors does not affect each of the abilities, and only some debilitating factors affect some abilities. For example, Reasoning can be degraded by Fatigue, Diurnal Rhythm, and Stress. However, Memory is affected only by Stress. In this analysis, the maximum number of adverse impacts on a task (within a given platoon action) that is theoretically possible is 16.

Table 3.5

Summary of Factors Degrading Critical Abilities

Depresses →	Communication	Dynamic Precision	Hearing	Memory	Numerical Facility	Orientation	Perceptual Speed	Reasoning	Vision
FATIGUE (SLEEP LOSS)			✓		✓	✓	✓	✓	✓
DIURNAL RHYTHMS					✓			✓	
LIGHT LEVEL/VISIBILITY		✓	✓			✓			✓
STRESS	✓			✓			✓	✓	

Accordingly, Table 3.5 constitutes one set of axioms for the formal (mathematical) model from which all quantitative projections in these Guidelines derive.

Digest of Critical Tasks and Their Performance

Succeeding portions of this chapter present detailed descriptions of what is known about how the conditions associated with continuous operations affect the performance of each of the 76 critical tasks of the Mechanized Infantry. Derivation of task criticality is fully described in a companion report, Background Data, Volume III Human Performance in Continuous Operations Guidelines. Here, the performance of each task is reviewed in terms of its behavioral requirements. For example, the G/CTL's Task No. 15, "maintaining concealed disengagement," requires the critical abilities, Orientation, Memory, and Reasoning, which are affected by Fatigue, Darkness (Light Level), and Stress.

The relationships between a critical ability and one of the unique stressors of continuous operations are presented with reference to one task for which the ability is critical and which exemplifies the need for the ability and the effect of varying the condition discussed. The remaining tasks show an index which lists the critical performance abilities required, the conditions which affect them, and the critical tasks in connection with which the appropriate relationships are discussed. Unless otherwise noted, the interpretations and implications for succeeding tasks are the same as for the task under which they are discussed. Table 3.6 identifies where a discussion appears on how debilitating factors degrade the ability of Mechanized Infantry, e.g., personnel to perform their tasks. This discussion is also relevant to FIST, Artillery, and Armor personnel where tasks demand common abilities.

The task digests which follow provide, in each case, a compendium of information pertaining to each of the identified critical tasks. Each digest provides the basic identifying information: Task No., the Duty Position which normally carries out this task, and the task title. Then, the type of defensive (platoon) action in which this task is highly critical is indicated. Next, the critical abilities required for task performance are listed together with the adverse, debilitating factors impacting upon and depressing the abilities. Also listed are those task numbers under which impacts of debilitating factors on abilities are discussed. Where appropriate such a discussion follows within the task digest.

Table 3.6

Mechanized Infantry: Index of Discussions of Effects of Debilitating Factors on Critical Abilities

Debilitating Factor	Critical Ability	Discussed Under Task No.
Fatigue	Vision	1, 30, 33
	Hearing	19, 33
	Numerical Facility	57, 66, 68
	Reasoning	57, 66, 68, 74
	Perceptual Speed	29, 30, 57
	Orientation	7, 29, 33
Diurnal Rhythm	Numerical Facility	11, 57, 61
	Reasoning	11, 57, 61
Light Level	Vision	9, 26, 44, 72
	Hearing	22, 33
	Dynamic Precision	18, 20
	Orientation	7
Stress	Memory	56, 59
	Reasoning	45, 53, 54, 74
	Perceptual Speed	2, 6
	Communication	48

NOTES: 1. Task Nos. in body of table refer to task digests appearing hereafter in this chapter.

2. Discussions in task digests are also relevant to Armor, Artillery, and FIST where common abilities are required.

CRITICAL TASK 1

Position: Gunner/Carrier Team Leader

Task: Fire From Bounding Vehicle

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6

DISCUSSION

One of the critical abilities required to fire effectively the .50 cal weapon at a moving target from a moving vehicle or from a hull down vehicle is the ability to track visually a moving target. The following figures show how this performance will be affected in a situation such as a prolonged mounted battle, or, in the case of the present platoon actions, a visual tracking task when the platoon members are fatigued.

Interpretation

Figure 3.4 shows that tracking performance deteriorates as a function of time on the task. Both time off target and number of times off target (errors) became more prevalent with prolonged execution of the task. Two important properties of this relationship are: (1) the deterioration is progressive over time,

and (2) a 15 minute rest period every five hours improves performance, but performance does not return to normal. The tracking behavior of a fatigued gunner, then, will be less precise than that of a rested gunner. The curves suggest up to a 25 percent decrement in visual tracking performance due to fatigue.

Implications

The clear cut implication is that tracking performance will be poorer for the fatigued gunner. On the basis of the extracted estimate of a 25 percent decrement, the effects on their 50/50 hit rate distance as compared with baseline 50/50 hit rate distance for first round firing are:

	Target	Baseline	Fatigued
Stationary Vehicle	Point	500m	375m
	Armored	800m	600m
	Area	1000m	750m
Moving Vehicle	Team-Size	300m	225m
	Squad-Size	500m	375m

The solution to this shortfall is to plan strategy such that effective ranges for successful completion of a mission are adjusted to allow for the decrease in hit rate distance. One such method would be to increase firing rates and to reduce reliance on first hit success when gunners are fatigued.

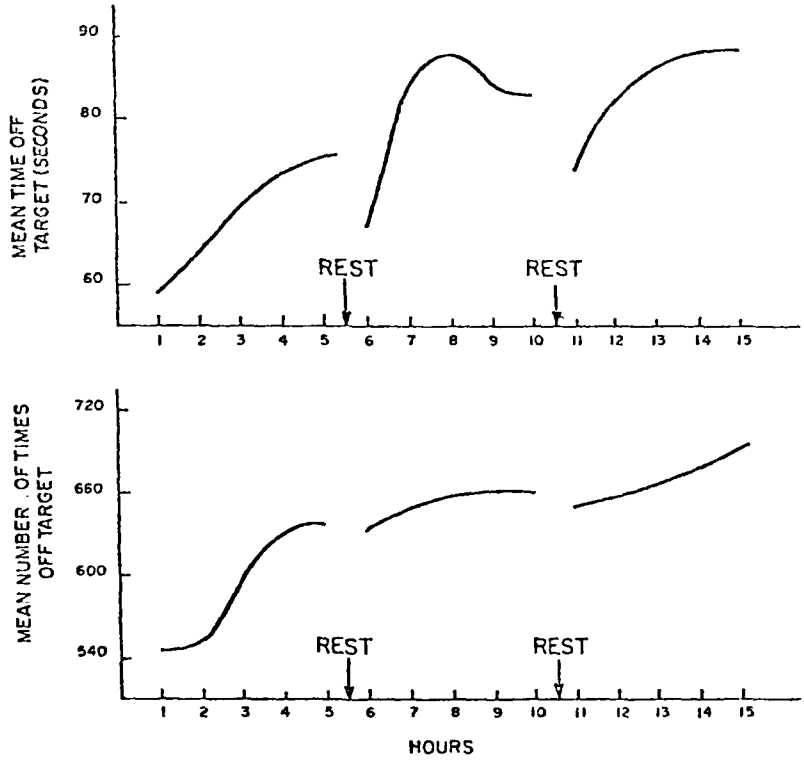


Figure 3.4. Effect of engaging in a complex visual tracking task for long periods of time.

and (2) a 15 minute rest period every five hours improves performance, but performance does not return to normal. The tracking behavior of a fatigued gunner, then, will be less precise than that of a rested gunner. The curves suggest up to a 25 percent decrement in visual tracking performance due to fatigue.

Implications

The clear cut implication is that tracking performance will be poorer for the fatigued gunner. On the basis of the extracted estimate of a 25 percent decrement, the effects on their 50/50 hit rate distance as compared with baseline 50/50 hit rate distance for first round firing are:

	Target	Baseline	Fatigued
Stationary	Point	500m	375m
Vehicle	Armored	800m	600m
	Area	1000m	750m
Moving	Team-Size	300m	225m
Vehicle	Squad-Size	500m	375m

The solution to this shortfall is to plan strategy such that effective ranges for successful completion of a mission are adjusted to allow for the decrease in hit rate distance. One such method would be to increase firing rates and to reduce reliance on first hit success when gunners are fatigued.

CRITICAL TASK 2

Position: Gunner/Carrier Team Leader

Task: Overwatch Bounding Vehicle

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Hearing	Light Level/Visibility	22, 33

DISCUSSION

In a continuous operation, the platoons and teams may need to relocate frequently. The resultant, ever changing battlefield will cause personnel (such as the gunner) to be exposed to the performance of a given task under varied circumstances. Of interest here is the question of the effect of this changing battlefield and the repeated performance of overwatching a bounding vehicle under different circumstances on the gunner's ability to detect enemy forces which could threaten the bounding vehicle. The variable of interest is expectancy. The proportion of enemy detections which occurred in preceding incidents of performing this task will affect the expectations of such enemy detection in succeeding incidents of overwatching a bounding vehicle. Figure 3.5 shows the effects of prior detection on present, reported detections.

Interpretation

It is necessary to show the effect of expectancy in this somewhat theoretical way. However, the effect is well known. In the detection situation, the percentage of signals detected is shown to depend on the perceived likelihood of a

signal being present. The actual number of signals does not matter. It is their relative proportion that influences expectations. For the gunner, the relative proportion of enemy encounters will influence his expectation of an encounter. This expectation, in turn, will influence the probability that the gunner will detect the presence of an enemy element which could threaten a bounding vehicle. If the enemy was encountered often in previous movement, it is more likely that the gunner will detect the presence of an enemy element in succeeding encounters. If, on the other hand, enemy encounter was infrequent, then the probability that the gunner will detect enemy presence is reduced. Expectation is not the only factor contributing to the probability of detection. How expectation will affect this probability cannot be stated quantitively for all situations. But in the example shown, when the expectation was that a signal (the analog of a to be detected target) would be present 50 percent of the time, the signal was detected roughly between 70 and 90 plus percent of the time. When that same signal was only expected 12 percent of the time, the signal was detected between 50 percent and 70 percent of the time.

Implica ions

Although the probability of detecting an enemy target which could threaten a bounding vehicle cannot be quantitatively related to the gunner's expectation of encountering an enemy, the relationship is clearly demonstrated. A series of movements in which a gunner has not detected the presence of enemy elements which could threaten a bounding vehicle will lead to a reduction in the probability that the gunner will detect an enemy element on subsequent movements.

The appropriate correction for this potentially dangerous effect is for the PL to advise the gunner of how this expectation adversely affects his ability to detect the enemy and to communicate to the gunner the actual best estimate based on battlefield intelligence of the probability of enemy detection during a specific movement.

This relationship as it affects this task and all other tasks subsequently referred to points to an important potential training area. Perceptual evidence is often not clear cut. It is assessed in terms of subjective expectation. Training troops to recognize this fact will be beneficial. And, it may be that specific programs can be developed in combination with specific aids, such as specially programmed calculators, which will assist soldiers in properly establishing probabilities.

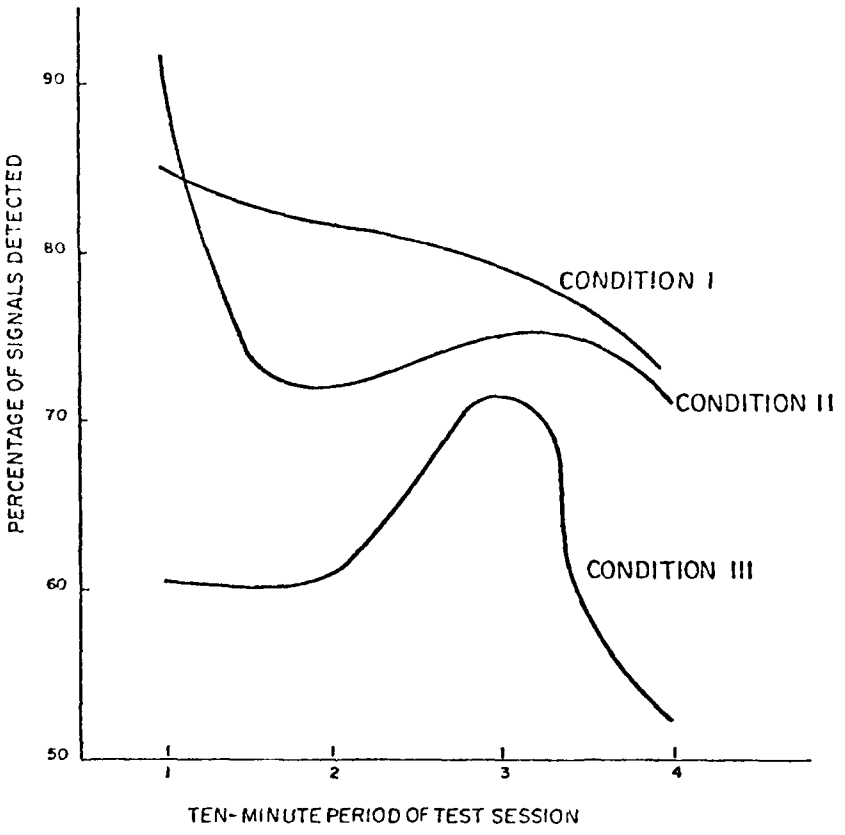


Figure 3.5. Effects of signal rate on detection probability.

Condition I = 144 events; 50 percent signals
Condition II = 24 events; 50 percent signals
Condition III = 144 events; 12 percent signals

CRITICAL TASK 3

Position: Gunner/Carrier Team Leader

Task: Fire To Protect Bounding Vehicle

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Hearing	Light Level/Visibility	22, 33

CRITICAL TASK 4

Position: Gunner/Carrier Team Leader

Task: Overwatch Dismount

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Light Level/Visibility	22, 33

CRITICAL TASK 5

Position: Gunner/Carrier Team Leader

Task: Fire .50 cal At Areas

Highly Critical in Platoon Actions:

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Dynamic Precision	None	
Vision	None	
Orientation	None	

CRITICAL TASK 6

Position: Gunner/Carrier Team Leader

Task: Coordinate Firing With Other Vehicles and Dismounted Elements

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
Dynamic Precision	Light Level/Visibility	20
Memory	Stress	56, 69

DISCUSSION

In every battle, it is essential that the gunner coordinate his fire with that of other vehicles, maneuver team elements, and other support weapons (tanks, artillery, etc.). In continuous operations, the battle scene will be highly mobile. As teams move from position to position or platoons frequently relocate, the amount of information that the gunner must consider in order that he can quickly and accurately coordinate fire increases greatly. The following relationship shows how the speed with which a task such as this, which requires integrating information from several sources and choosing one of several alternative responses to that information, is decreased as the number of alternative responses or courses of action increase.

Interpretation

Figure 3.6 shows that for tasks that require very quick responses, as the number of alternatives increases, so will the time it takes to formulate a response. There are times when, for example, the gunner may detect a possible enemy target. He must rapidly and accurately decide whether or not it is in fact the enemy, whether or not it is within his zone of responsibility, whether the target is within range, and whether or not he should engage the target. As the continuous operation wears on, the intellectual load involved in keeping track of who's who and who's where will create increasingly large numbers of alternatives to consider. The graph shows that what the gunner could do in less than two tenths of a second with only one alternative will take well over half a second with seven or more alternatives. In many firing situations, reaction times required will be of the times shown and the difference between two tenths of a second and six tenths of a second may be vital.

Implications

The soldier in continuous warfare will find that the continuously changing battlefield will increase the number of perceptual alternatives to be considered in tasks which require rapid processing of the information and extremely rapid responses, such as those often required of the gunner in coordinating his fire with that of other elements.

Frequent updating, integration, and summarization of the overall and specific battle situations, maximally informative range cards and TRP identifications, and well thought out and developed SOPs represent methods for minimizing the detrimental effect of this shortfall.

This last point, the preparation to be made beforehand, cannot be overemphasized. The thrust of the preceding remarks is that the soldier should be: (1) over trained for battle, (3) well-versed and rehearsed in appropriate procedures, and (3) provided with the best decision making devices for updating in battle the appropriate responses.

The training might involve the use of battle simulators, case method study, and maneuver practice. The important point is that cognitive practice as well as performance practice must be given. Additionally, detailed briefings including specific discussion of possible alternative courses of action will be helpful.

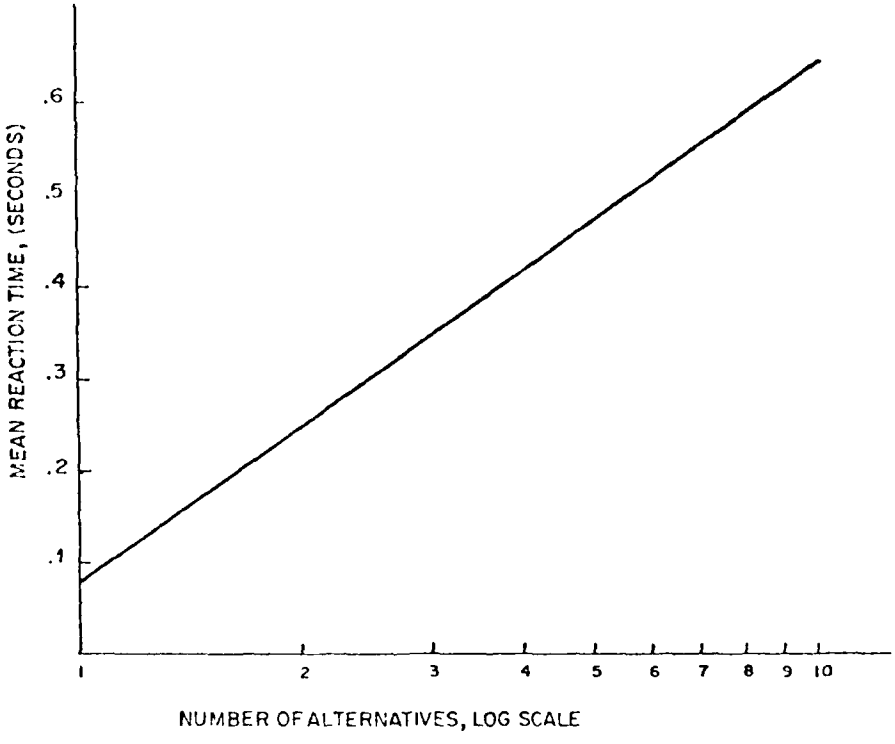


Figure 3.6. Reaction time with varying numbers of alternative responses.

CRITICAL TASK 7

Position: Gunner/Carrier Team Leader

Task: Maintain Knowledge of Squad's Location

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69

DISCUSSION

People differ in their ability to maintain orientation. The need to know where one is and where other objects or persons are relative to oneself is exemplified in this task. The Carrier Team Leader must know where he is and where he is going in order to complete effectively this task. The following relationship shows how orientation ability relates to experience with the environment and to individual abilities.

Interpretation

Figure 3.7 shows that there are two kinds of people: poor and good sense-of-direction people. Those who have a poor sense-of-direction (and self evaluation of ability in this regard is quite good) show no improvement in orientation after repeated exposures to the same environment. Those who have a good sense-of-direction become better in orientation with more experience with the same environment. Experience provided by map familiarization, reconnaissance, and briefings will help improve orientational performance.

There is some evidence that one of the operative factors that distinguish good from poor sense-of-direction people is good versus poor memory.

Implications

Those individuals with the primary responsibilities for orientation, as in the case of the Carrier Team Leader engaged in directing relocation or repositioning of his APC, should be preselected individuals with a good sense-of-direction. To identify these individuals, tests of memory, and self-reports (which, surprisingly, are one of the best predictors). Orientation ability is severely affected by sleep loss.

In tests conducted by the British Army, cognitive tasks most severely affected by sleep loss were encoding, decoding, logical reasoning, and accurate perception/concentration. All of these abilities are related to maintaining orientation. At night the orientation problem becomes even more severe. The Soviets are convinced that if orientation is lost at night, confusion, panic, and passivity may occur. Accordingly, they institute measures to maintain position, direction, and especially orientation. To permit the dismounted infantry to guide on their fighting vehicle, the Soviets have a shielded red light in the rear of their BMP. They also employ identification lights--some combination of red, green, and amber.

The role of memory appears to be quite important, especially at night when the visual cues to orientation will be diminished. Landmarks to be remembered must be learned. When possible, as much experience as is possible should be given with the environment in which orientation is to be maintained. Extensive briefings with maps and photographs (or other topographical representations) should be given.

Finally, aids, such as compasses, radar, and others, should be provided and their use should be well learned.

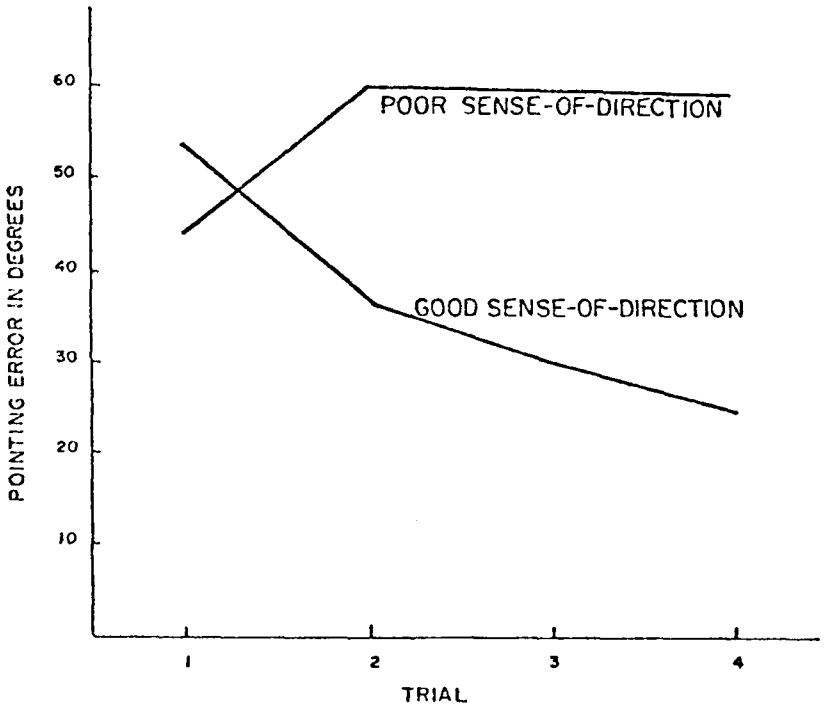
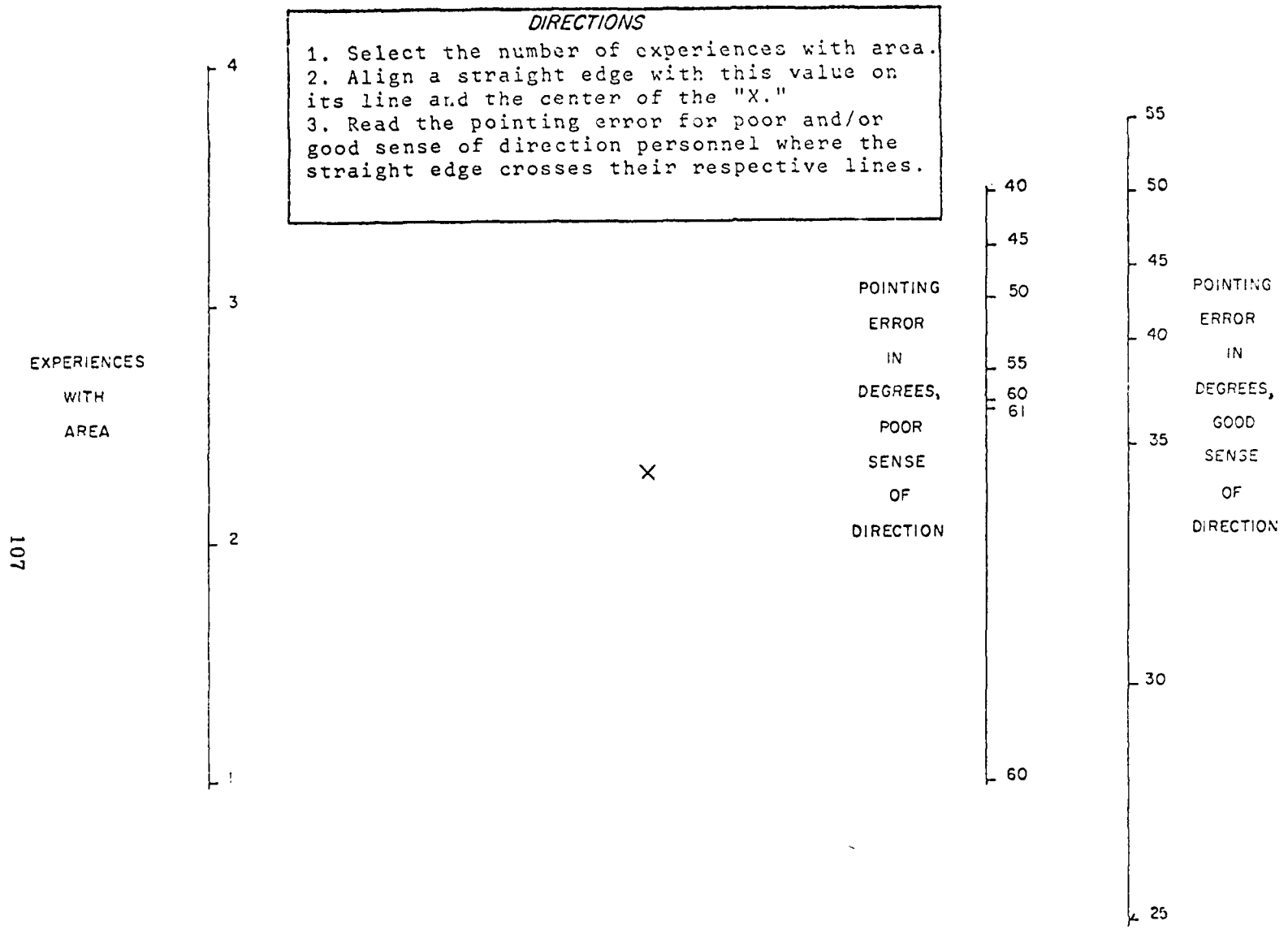


Figure 3.7. Ability to identify one's relative position with practice for self-reported good and poor sense-of-direction people.



Nomograph showing pointing errors as a function of familiarity with area.

CRITICAL TASK 8

Position: Gunner/Carrier Team Leader

Task: Communicate With PL

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 9

Position: Gunner/Carrier Team Leader

Task: Detect Enemy Movement

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
Perceptual Speed	Fatigue	29, 30, 57

DISCUSSION

This task requires the carrier team leader to detect whether or not an enemy target, such as a tank or BMP or other vehicle, is approaching the gunner's location. The information presented in the following graphs concerns the special case of detecting the movement of such a target toward the gunner on a very dark night, i.e., on a night with a light level below that given by a full moon.

Interpretation

Figures 3.8-3.10, taken as a group, indicate that the following factors operate against the gunner in detecting an oncoming target in this situation:

- the target is too dim
- the target is moving too slowly
- the target moves over a small distance only
- the gunner uses (or must use) monocular vision.

While the situations, on which the figures are based, are somewhat artificial, the speeds, and sizes, and distances are equivalent to a threat T-62 tank approaching from a distance of 225 M at a speed of 9 km/hr.

Figure 3.8 shows the detection probability for targets of varying brightness which have travelled varying distances. The curve for a target of .001 ft. L most closely represents an approaching tank. Notice that at 9 km/hr, the tank would have to approach nearly 45m from a starting distance of 225m before the naked eye will likely detect its approach.

Figure 3.9 shows the advantage of two eyes over one eye, an advantage which is especially great for dim targets such as an approaching tank at night.

Figure 3.10 presents the problem in terms of the viewing time necessary to detect motion for varying target speeds. The data have been extrapolated for the case of the tank.

Implications

The major implication of these relationships is that when insufficient light is available for identifying the approach of an enemy tank (or any other moving target) by comparing its relationship to other objects, then the luminance of the target and its speed will limit the ability of the gunner to detect its approach. In daylight, such movement could be detected in less than a third of a second. At night it could take up to 6 seconds to detect the movement. This amount of time could be critical if the target's movement will dictate the gunner's next response.

Suggestions for overcoming this problem involve training in the use of minute cues such as the small change in size occurring because of an object's approaching a short distance, training in the use of nonvisual cues such as hearing, training in positioning oneself to allow contextual cues to be present against which an approaching object's movement can be viewed, or training to position oneself to take advantage of maximum ambient illumination, such as in a location from which the moon, if present, is most likely to cast the most light on an approaching tank.

The use of night vision aids or even binoculars will help immensely.

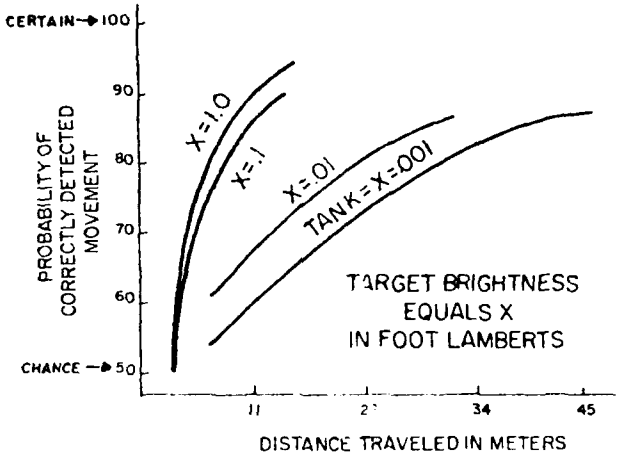


Figure 3.8. Accuracy of detecting targets (including T-62 tank at 225 M) moving toward or away from viewer at about 9 km/hr.

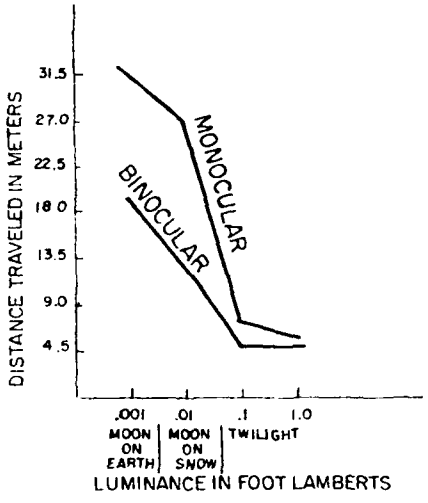


Figure 3.9. Effect of using one versus two eyes on detecting movement toward or away from a viewer.

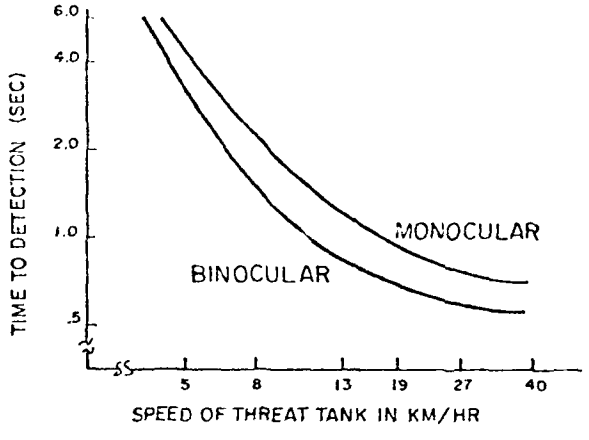
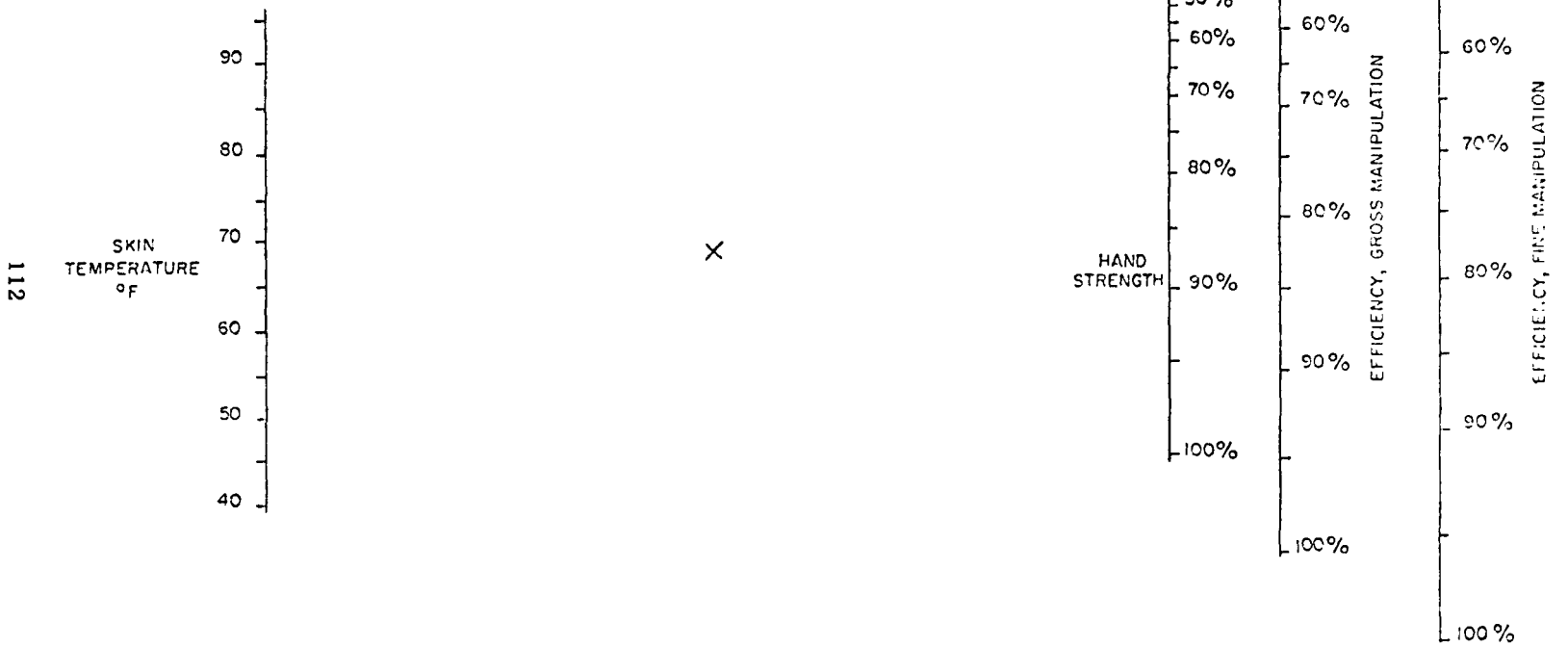


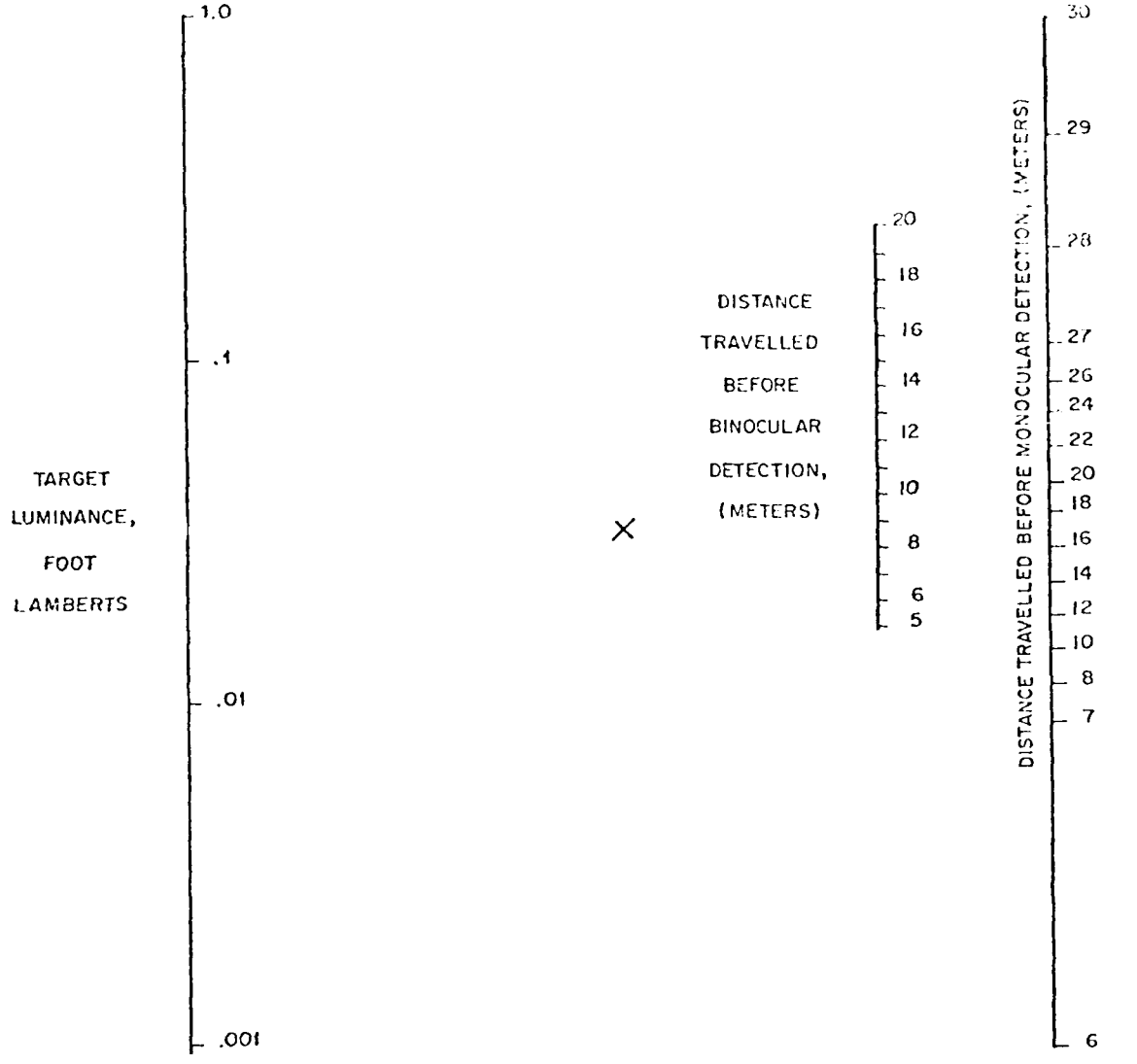
Figure 3.10. Effect of rate of movement on movement detection.

DIRECTIONS

1. Select the skin temperature of the hand.
2. Align a straight edge with this value on its line and the center of the "X."
3. Read the efficiency of hand strength, gross manipulation, and/or fine manipulation where the straight edge crosses their respective lines.



Nomograph relating skin temperature to hand strength and efficiency of manipulation.



DIRECTIONS

1. Select the target brightness.
2. Align a straight edge with this value on its line and the center of the "X."
3. Read the distance travelled before detection, monocular and/or binocular, where the straight edge crosses their respective lines.

Nomograph relating target brightness and movement distance required for detection.

CRITICAL TASK 10

Position: Gunner, Carrier Team Leader

Task: Determine Need to Relocate

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74

CRITICAL TASK 11

Position: Gunner/Carrier Team Leader

Task: Establish Revised TRP's and Range Cards

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69
Vision	Light Level/Visibility	9, 26, 44, 72

DISCUSSION

This task requires reasoning and mental manipulation of numbers. It is likely that the effects on this task of diurnal rhythms and fatigue are the same or similar for other intellectual tasks. Accordingly, the effects might be considered as a general description of how performance will be modified by a rapid change in the relationship between when the tasks have typically been performed (day or night) and when the contingencies of continuous operations require their performance.

Interpretation

The first point of interest is the effect of fatigue. Notice in Figure 3.11 that during two duty weeks which were studied, as the night wore on, performance deteriorated. In both cases, performance decreased over the first 10 hours and apparently became no worse during the remaining six hours.

The effect of inverting the diurnal rhythms is that an adjustment period is necessary. This adjustment period is reflected by the relative superior average performance in the second week compared with the first week. Over long periods of time, people tend to perform given activities at specific times of the day. One explanation for the effects of inverting diurnal rhythms says that the set of environmental stimuli, including possible biological states of the body which vary over a twenty-four hour period (called circadian rhythms), are involved in the habits that people have developed. Accordingly, when one is asked to do something out of phase with the customary time of performance, all of the time-of-day related factors are no longer present to encourage maximum performance. Whatever the explanation, the data clearly indicate that a drop in performance is to be expected and must be overcome. The adjustment period seems to be in excess of one week.

Implications

The clear implication is that a sudden inversion of diurnal rhythms will result in a significant deterioration in mental performance. An adjustment period in excess of one week, which exceeds the boundaries of the present scenario, will be required.

The major keys to overcoming this problem are training and anticipation. The kind of training required to correct this deficiency involves performance of the relevant tasks at varying times of the day. The need to conduct training operations as much at night as in the day may be the single most important training recommendation to emerge from the human performance literature.

Anticipation of performance decrements that might result from performance of mental tasks out-of-phase relative to time-of-day is a helpful forewarning. Creating decision aids and devices for assisting in the performance of these and other mental tasks will contribute toward nullifying the negative effects of inverted diurnal rhythms.

The present discussion was concerned with inverted diurnal rhythms. It presumed that some sort of cycle of behavior would be perpetuated that is out of phase with its normal time of day. When prolonged battle forces abandonment of the normal cycles of behavior, a different problem exists, called disruption of diurnal rhythms. For a discussion of this problem, see Critical Task 61.

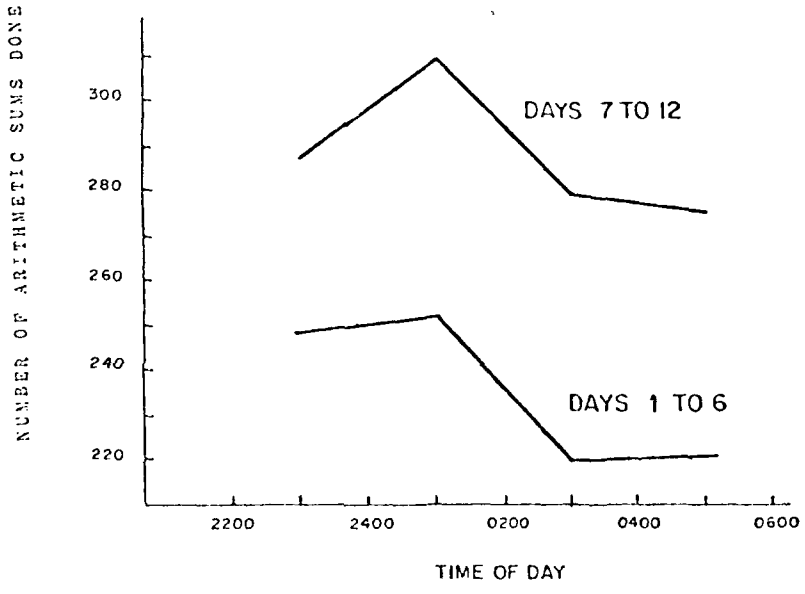


Figure 3.11. Average rate of work of enlisted men on night duty for first and second week.

CRITICAL TASK 12

Position: Gunner/Carrier Team Leader

Task: Direct Relocation or Repositioning

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Vision	Light Level/Visibility	9, 26, 44, 72
Hearing	Light Level/Visibility	22, 33
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 13

Position: Gunner Carrier Team Leader

Task: Reposition To Allow Other Weapons To Fire

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Numerical Facility	Diurnal Rhythm	11, 57, 61
Reasoning	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Vision	Light Level/Visibility	9, 26, 44, 72
Communications	Stress	48

CRITICAL TASK 14

Position: Gunner/Carrier Team Leader

Task: Cover Disengaging Squads

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6

CRITICAL TASK 15

Position: Gunner/Carrier Team Leader

Task: Maintain Concealed Disengagement

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69
Reasoning	Stress	45, 53, 54, 74

CRITICAL TASK 16

Position: Gunner/Carrier Team Leader

Task: Fire To Protect Regrouping

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 71
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74

CRITICAL TASK 17

Position: Gunner/Carrier Team Leader

Task: Report Vehicle Readiness to SL

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	None	

CRITICAL TASK 18

Position: Maneuver Team Member

Task: Check Condition of Weapons

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Dynamic Precision	Light Level/Visibility	18, 20
Reasoning	Stress	45, 53, 54, 74

DISCUSSION

A typical night battle will be fought in temperatures which are colder than daytime battle temperatures. As the hands are exposed to colder temperatures, the hand skin temperature (HST) drops. As the HST is lowered, the hands become less efficient at almost any manipulative task. The Maneuver Team Members will be required to check the condition of their weapons periodically. This will include manipulating small items and will require manual dexterity. Figures 3.12 and 3.13 show the effects of a drop in HST on manipulative performance.

Interpretation

Even a slight drop in HST negatively affects performance. The amount of strength as measured by a hand dynamometer and the ability to manipulate large objects (large machine nuts) and small objects (small screws) are shown to be impaired by a drop in HST. By the time HST drops below 15°C (60°F), all three measures show a dramatic decrease in efficiency. The hand dynamometer and the manipulation of large objects show a 40 percent efficiency decrease; the manipulation of small objects shows a 60 percent decrease. Since

the latter two tasks were performed in a fixed amount of time, the decrease in efficiency can also be interpreted as an increase in the amount of time required to perform the task. Figure 3.13 shows a similar relationship for knot tying when HST is 13°C (55°F). It also shows that performance deteriorates with prolonged exposure to low HSTs, and that after 40 minutes exposure, the decrement in performance will be at its maximum.

Implications

The Maneuver Team Members will require up to 60 percent more time to check the condition of their weapons when their HST has dropped below 15°C. Nearly doubling the time required to perform these tasks is very dramatic. The principle compensations for this decrement, unless the task can be performed with gloves on, is to be aware of its existence, to overtrain the task so that the associated decrement will be adding time to a minimum base time, and to provide some means of warming the hands before the weapons are to be checked (e.g., assuring that all persons wear gloves before the weapon check and checking weapons with gloves off). Where possible, procedures can be designed to allow more time for these tasks. Finally, in the case of temperature reduction associated with nightfall, routine manipulative tasks, such as this, can be scheduled earlier--before the temperature drops.

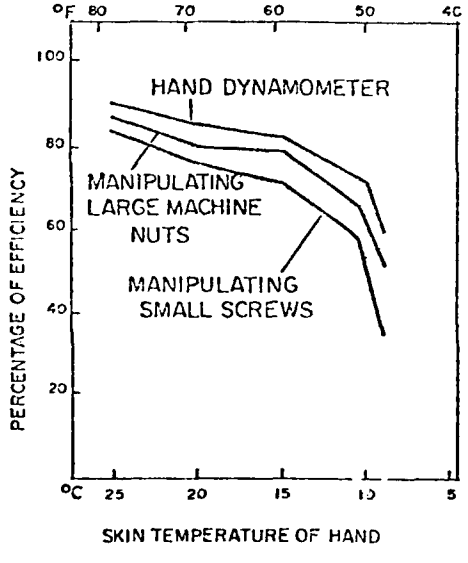


Figure 3.12. Deterioration of manual task performance as hand-skin temperature falls.

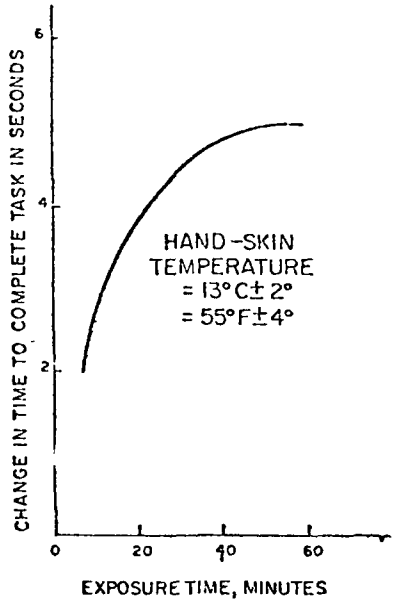


Figure 3.13. Increase in knot-tying time as a function of exposure to a low hand-skin temperature.

CRITICAL TASK 19

Position: Maneuver Team Member

Task: Detect Targets in Exposed Position from a Bounding Vehicle

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Memory	Stress	56, 69

DISCUSSION

The Maneuver Team Members will be required to detect targets after periods of sleep loss. Some of the target detection may be auditory, that is, the soldiers will listen for sounds which indicate enemy presence. Figure 3.14 shows the effect of sleep loss on auditory vigilance.

Interpretation

The points on Figure 3.14 at 7.5 hours sleep represent the "normal" adult sleep requirements. The other points represent the amount of sleep allowed on the first night (labeled 1 night) and on each of two nights (labeled 2 nights).

Each point represents a five hour auditory vigilance task that called for a difficult auditory detection. Notice that the less sleep allowed on the first night, the fewer the detections that were made. Performance drops from about 65 percent detection to about 53 percent detection. By the second night the effects are even more dramatic. Performance drops from 67 percent to 45 percent.

Implications

The effect of reducing sleep to three hours or less a night will have a marked deleterious effect on auditory vigilance. After one night of such sleep loss, the soldier's auditory detection ability will be impaired. After two night's of such sleep loss, the impairment will be more marked. Beyond the second night, one can expect further impairment.

The recommendations for correcting this shortfall are to reduce reliance on auditory detection, to coordinate the auditory vigilance of two or more soldiers, or to rely on intersensory validation. The value of intersensory validation is discussed under Critical Task 33.

As can be seen in this relationship, fatigue has far reaching effects. In general and wherever possible, a staggered sleeping schedule will help. The idea is to use personnel who are most rested for those tasks adversely affected by fatigue. Even brief, periodic catnaps just prior to engaging in such tasks may be highly beneficial. Some adaptation during training may be necessary before individuals are able to catnap, for example, in a moving, noisy APC.

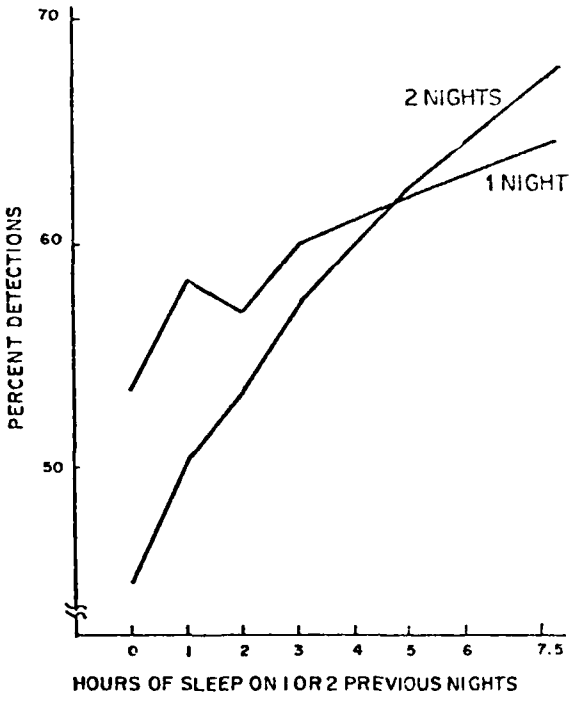
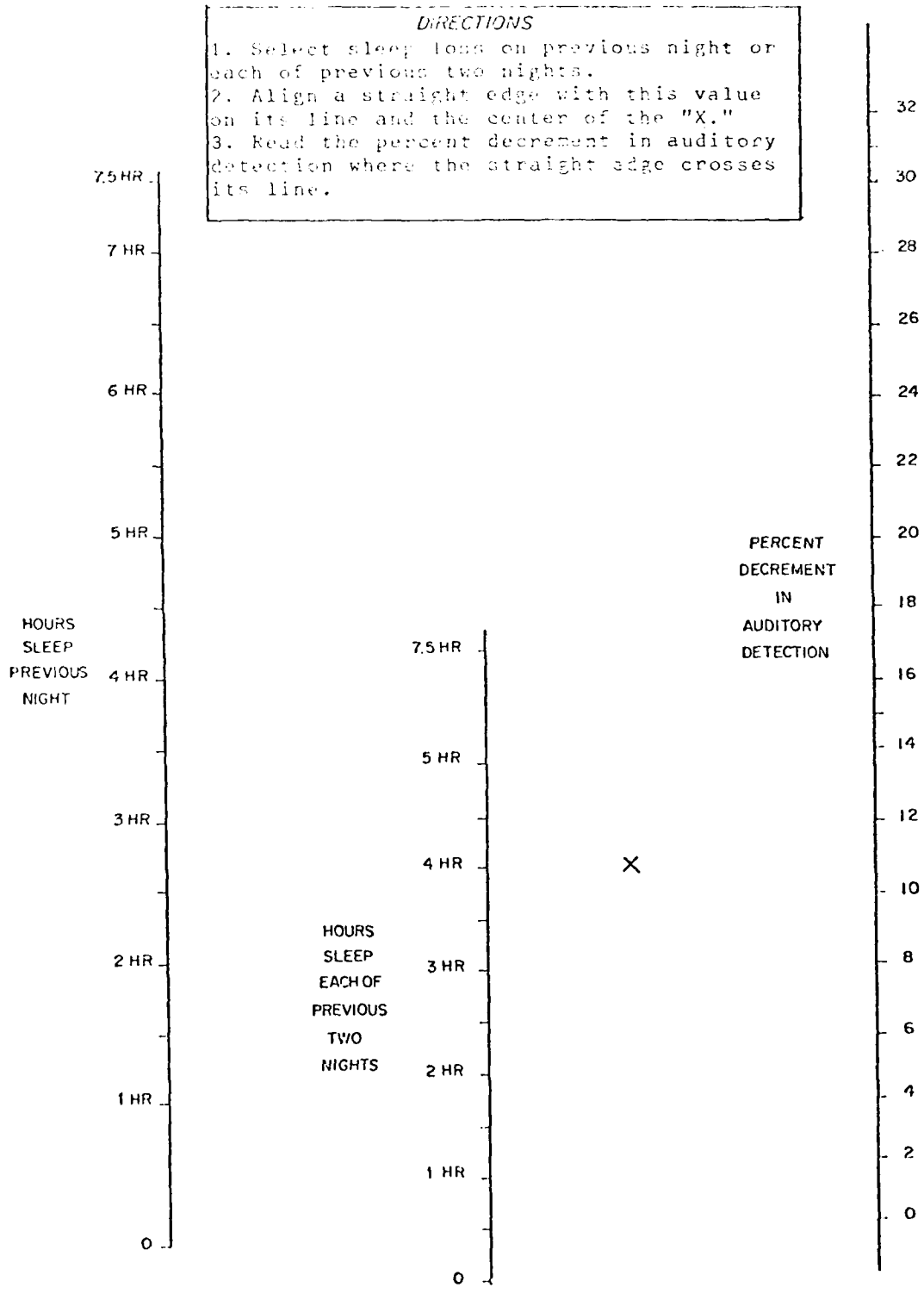


Figure 3.14. The effects of sleep loss over 1 or 2 nights on auditory vigilance.



Nomograph relating amount of sleep to auditory detection performance

CRITICAL TASK 20

Position: Maneuver Team Member

Task: Fire Weapons From Bounding Vehicle

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Dynamic Precision	Light Level/Visibility	18, 20

DISCUSSION

Firing weapons at areas at night involves directing the weapon at various angles, loading the weapon, clearing jams, and other activities which require dynamic precision. In at least some cases, the ability to line things up, based on cues associated with hand-arm movements, will be crucial. It is well known, of course, that such a task is difficult. We rely heavily on visual feedback for most tasks involving manipulation. Figure 3.15 shows the importance of visual feedback.

Interpretation

Figure 3.15 shows the performance difference when a task requiring precision is performed with the eyes closed or with eyes open. The eyes closed situation is equivalent to extreme darkness. Notice that tasks are performed considerably better when visual feedback is provided. The eyes closed situation provides a baseline. In this case, in which movement was to be made in the amount of time indicated, the error rate was about 7 percent. With eyes open, the error rate dropped. Accordingly, the importance and beneficial effect of visual feedback is clearly shown.

Implications

There are several solutions to the problem of deficient dynamic precision in the absence of visual feedback. One solution is typically used for firing some weapons at night. The use of stake markers to delimit the area to be covered by the weapon is an excellent example of providing a tactile, non-visual cue that does not depend on movement feedback. The general ways of compensating for such deficiencies are:

(1) Design weapons and arrange firing such that visual feedback are not necessary because of the provision of other feedback cues (auditory, tactile, or others)

(2) Provide artificial visual aids such as night vision goggles

(3) Practice the relevant actions to the point of overlearning so that each step requires no feedback.

This last suggestion can be understood by the example of a pianist. The pianist uses auditory and movement feedback cues to learn a piece of music. But eventually the pianist overlearns the "task" to the point where playing the piece constitutes a "motor program." Once this motor program is initiated, it follows through to a conclusion without feedback.

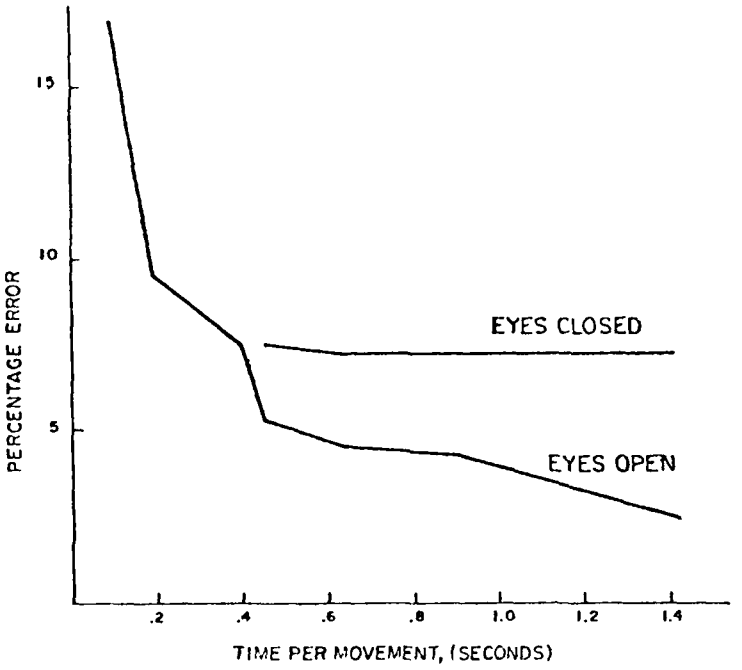
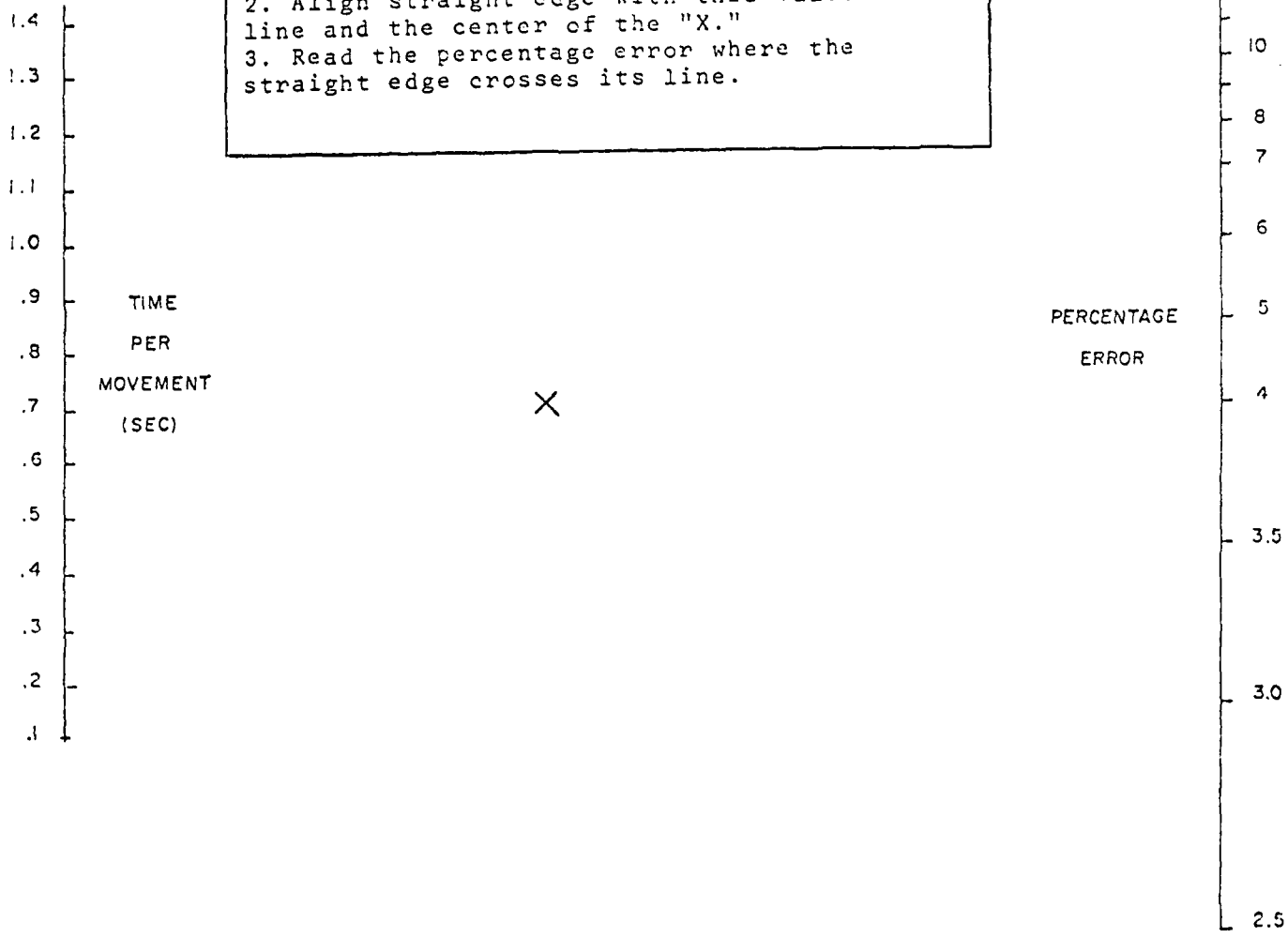


Figure 3.15. Relation between accuracy and duration of movement for two light level conditions.

DIRECTIONS

1. Select time per movement (without visual feedback).
2. Align straight edge with this value on its line and the center of the "X."
3. Read the percentage error where the straight edge crosses its line.



Nomograph showing relationship between movement time and accuracy.

CRITICAL TASK 21

Position: Maneuver Team Member

Task: Plan Fire Effective Positions

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74

CRITICAL TASK 22

Position: Maneuver Team Member

Task: Coordinate Weapon's Locations

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Orientation	Fatigue	7, 29, 33
Dynamic Precision	Light Level/Visibility	18, 20
Memory	Stress	56, 69
Communication	Stress	48

DISCUSSION

This task requires communication between leaders and Maneuver Team Members and among several Maneuver Team Members. When this communication is verbal, Figure 3.16 shows the effect of background noise on the ability to hear a speaker.

Interpretation

There are at least two ways in which the listener could be rendered incapable of seeing the speaker's face: (1) the speaker's face is outside of the field of view of the speaker, or (2) the light is insufficient to allow the listener to see the speaker's face. Under most night conditions, the listener will not be able to see the speaker's face. (Radio communication possesses additional intelligibility problems).

Note that when background noise increases to levels louder than the speaker's voice, the ability to hear the speaker deteriorates whether or not the listener can see the speaker's face. But, most importantly, note that the detrimental effect of background noise is much greater for the listener who cannot see the speaker. Hearing accuracy is reduced to near zero when the background noise loudness is 16 to 32 times greater than the speaker's voice. A truck or bus passing by at 20 feet or a pneumatic drill is 10 times louder than normal conversational speech. An elevated train is 32 times louder than normal conversational speech. An airplane engine (reciprocating) is 32 times louder than a shouting speaker.

Accordingly, a noisy battlefield environment at night will make voice commands nearly impossible to hear correctly even when these same commands could be understood in the daytime.

Implications

The major implication of this relationship is that at night reliance on verbal commands will be detrimental when background noise is high. The solution is to use a nonverbal command method. If giving away one's location is not a problem, a little cue might be appropriate. In other cases, the use of radio commands through headphones which attenuate the background noise might suffice. Other suggestions include such aids as developing and using a standardized, limited vocabulary; speaking louder or amplifying voice communication where appropriate; restricting briefings to the daytime; using written communications; and reinforcing speech with a sign language. The development of tactual or electrocutaneous signaling devices would also be helpful. Finally, the need to use commands in such environments can be eliminated or reduced by well thought out SOPs.

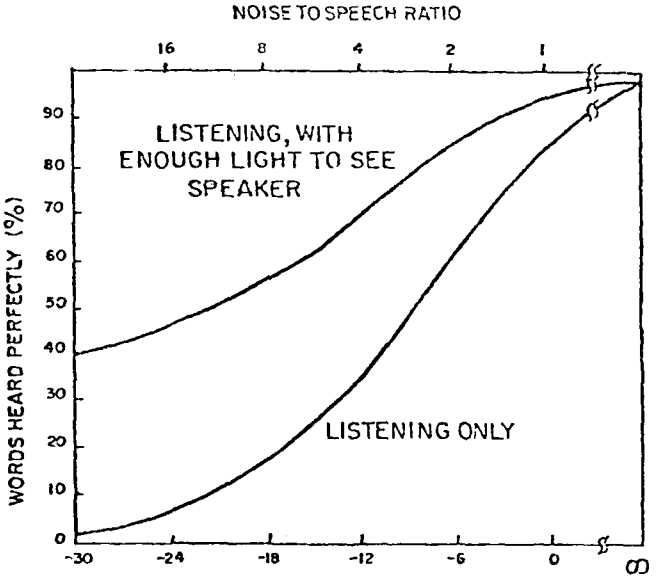
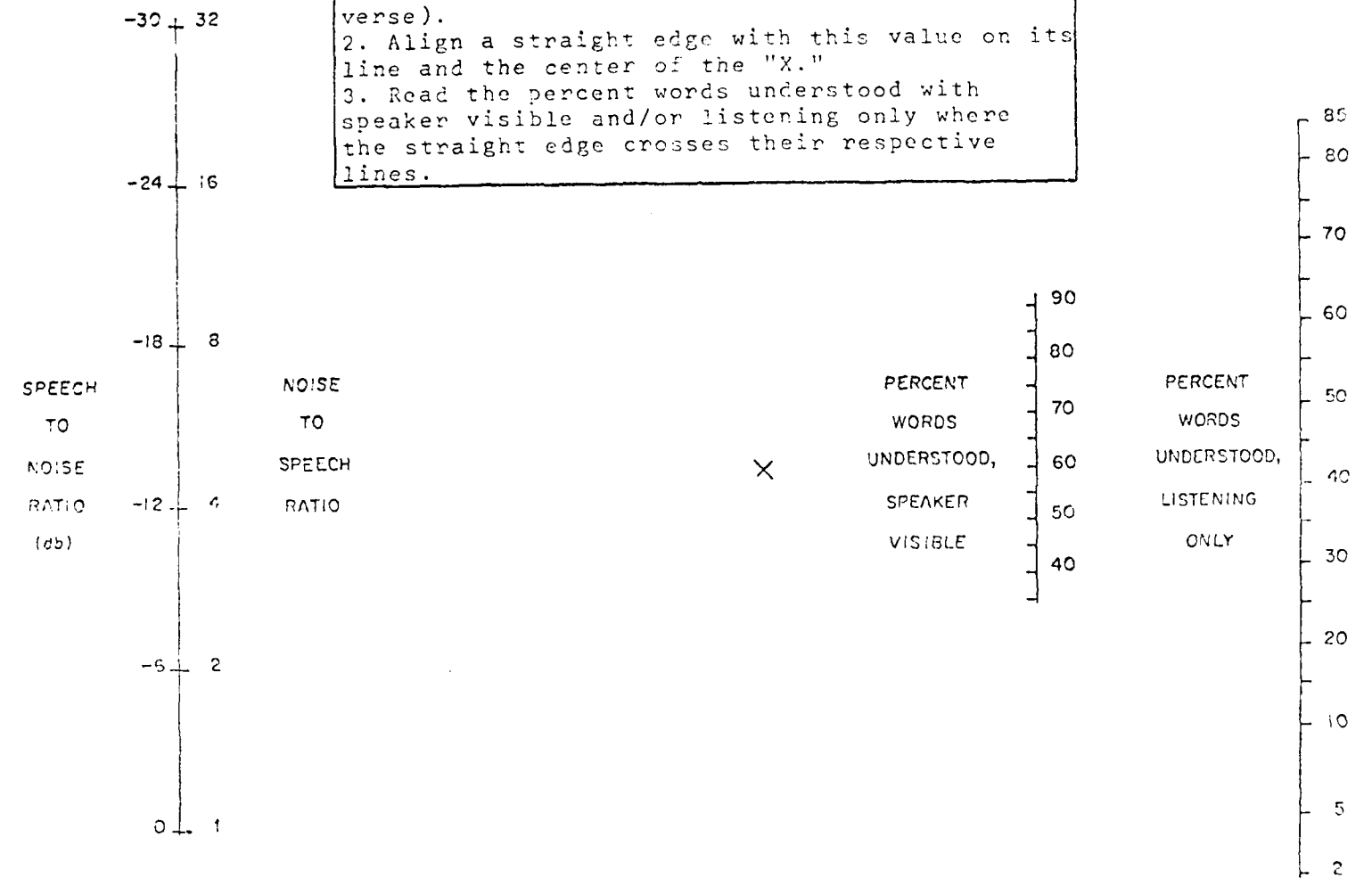


Figure 3.16. Intelligibility of words when perceived with and without visual cues from observing the talker.

DIRECTIONS

1. Select the speech to noise ratio (or the reverse).
2. Align a straight edge with this value on its line and the center of the "X."
3. Read the percent words understood with speaker visible and/or listening only where the straight edge crosses their respective lines.



Nomograph showing understandability of speech in noise.

CRITICAL TASK 23

Position: Maneuver Team Member

Task: Mark Routes Between Possible Locations

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
Vision	Light Level/Visibility	9, 26, 44, 72
Dynamic Precision	Light Level/Visibility	18, 20

CRITICAL TASK 24

Position: Maneuver Team Member

Task: Identify TRPs

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69
Perceptual Speed	Stress	2, 6

CRITICAL TASK 25

Position: Maneuver Team Member

Task: Plan Fire Cover for Possible Relocations

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Memory	Stress	56, 69

CRITICAL TASK 26

Position: Maneuver Team Member

Task: Fire on Targets

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Memory	Stress	56, 69

DISCUSSION

If effective fire is to be maintained, an accurate assessment of the points of maximum target vulnerability must be made. Several factors contribute to the likelihood of seeing a target well enough to fire effectively at the target. The set of graphs shows the effect of light level, target size, and contrast ratio on the visibility of targets. Visibility is expressed here as the distance from the soldier at which a target will be seen. The effect of the size of the target is shown by presenting visibility data for a large object (tank), a medium-sized object (jeep), and a small target (person).

Interpretation

To understand the meaning of these graphs, the term "contrast" needs to be defined. Values of percentage contrast from 1 to 10,000 are given here. The contrast value of 10,000 represents a target which is a little more than 100 times as bright as its background. For the value of 1,000, the brightness multiplier is a little more than 10; for the value of 100, it is 2. For the 10 percent and the 1 percent curves, the target is either brighter or dimmer than the background, with the difference between the target brightness and background brightness being 10 percent or 1 percent of the background brightness.

The graphs show the minimum distance at which the targets can be seen (99 percent of the time) at various background light levels.

The 1 percent and 10 percent curves represent the contrast that an enemy vehicle or soldier will present when he is attempting to avoid detection. Notice that at twilight, an enemy soldier or jeep will not be seen beyond less than 100m. Even on a bright but overcast day, an enemy soldier who is well camouflaged (1 percent) will be extremely difficult to see if he is beyond 300m.

Values of 100 percent contrast or greater would be those associated with a lighter target, either in a situation where the enemy is not attempting to avoid detection or as a result of artifical illumination provided, perhaps, by flares. Whether or not a contrast as high as 10,000 percent could ever be achieved on a battlefield has not been established. But, given such sharp contrast, even under starlight alone a person could be seen at 365m. Tanks and jeeps would present no problem at all up to 2000m.

On these graphs, when an object's visibility beyond 2200m is not limited by background illumination, the graph does not extend beyond the lowest background light level at which such light level does limit visibility within 2200m.

Implications

The implications for firing on targets are clear. At twilight levels and below, targets cannot be effectively engaged at appropriate distances using unaided vision. There is no way of improving the situation since the limiting factors are environmentally imposed. The only solutions are to provide artifical illumination (e.g., use of pyrotechnics).

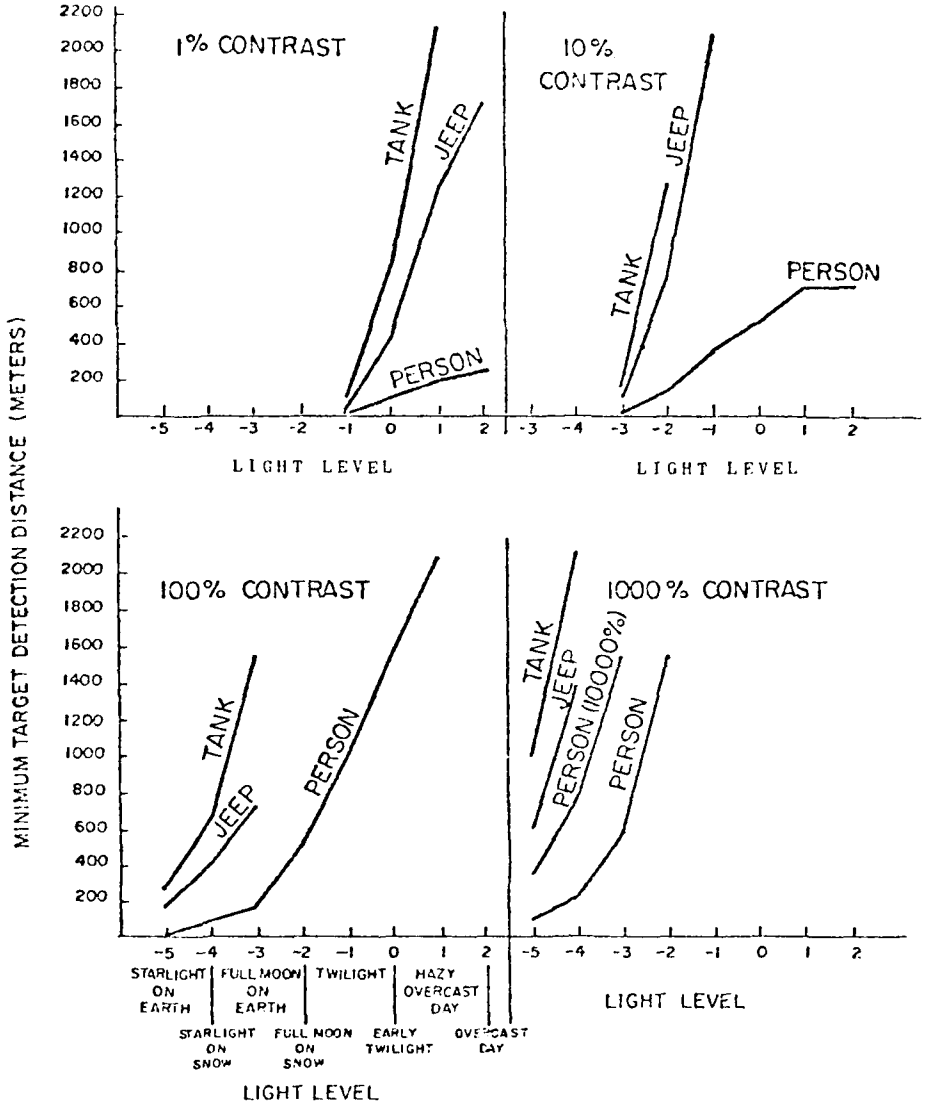
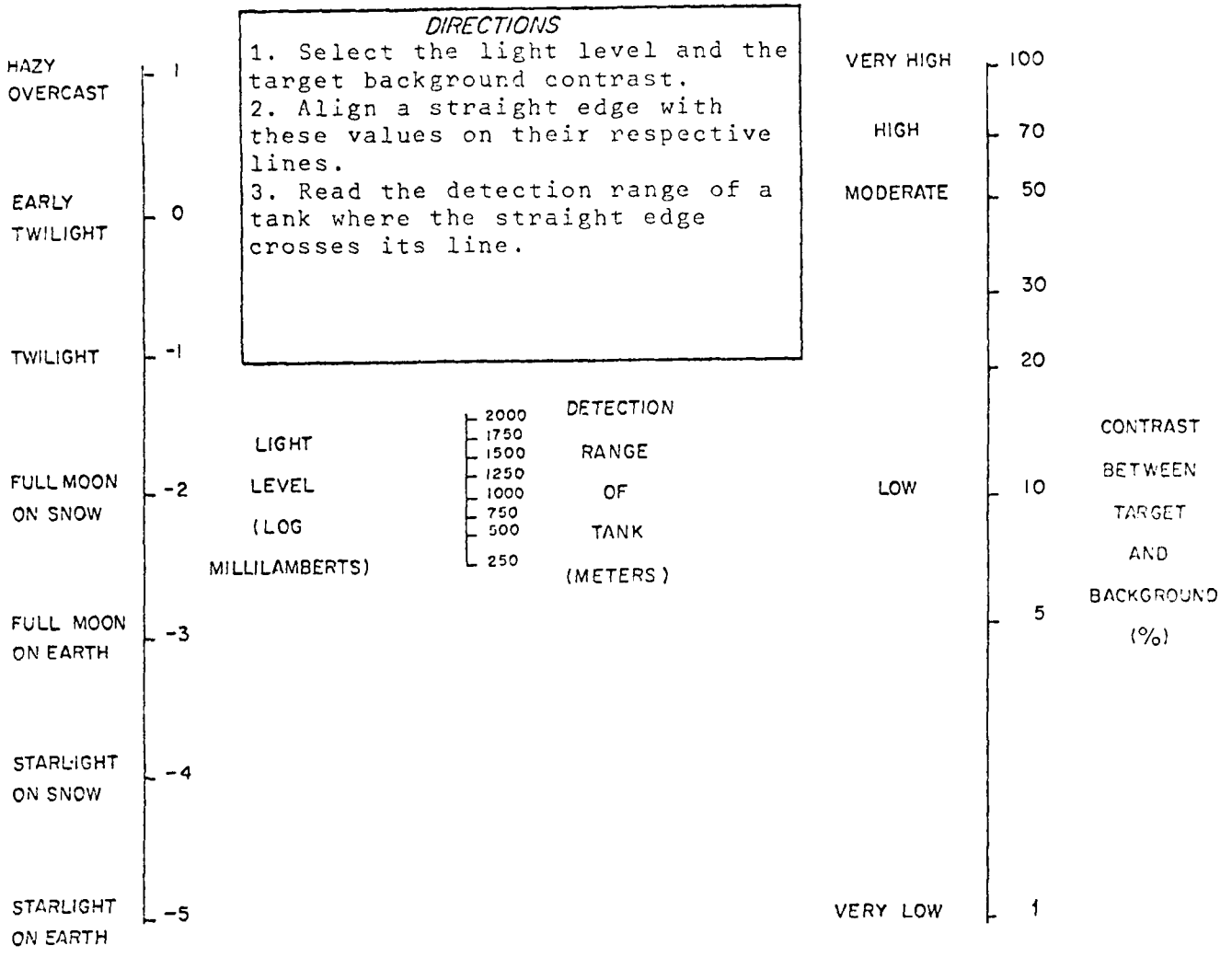


Figure 3.17. Effect of light level on visibility at various contrast ratios.



Nomograph for range of visual detection of tank as function of light level and contrast.

CRITICAL TASK 27

Position: Maneuver Team Member

Task: Fire at Areas

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	None	
Dynamic Precision	None	
Orientation	None	

CRITICAL TASK 28

Position: Maneuver Team Member

Task: Fire with NVDs

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Memory	Stress	56, 69

CRITICAL TASK 29

Position: Maneuver Team Member

Task: Move Rapidly to New Positions via Marked Routes

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Perceptual Speed	Fatigue Stress	29, 30, 57 2, 6
Vision	Light Level/Visibility	9, 26, 44, 72
Orientation	Light Level/Visibility	7

DISCUSSION

In continuous operations, members of fighting units will be required to perform perceptual motor tasks which require rapid perceptual discriminations when sleep periods have been reduced. The graphs show the effects of up to 48 hours without sleep on perceptual-motor performance and the recommended recovery period for varying hours of continuous operations without sleep.

Interpretation

The first graph shows how sleep loss affects performance of the perceptual-motor requirements of the task. Notice that performance is not affected to any marked degree through the first 17 hours. However, by 0900 of the second day, there is a 45 percent increase in errors. This indicates that the level of performance on tasks which involve perceptual-motor ability, such as finding the route markers while moving to a new position and maintaining the ability to detect enemy presence enroute, would be well normal performance level. Note that the

decrement appears to level off at the end of day 2, perhaps even improve. This may be due to a diurnal rhythm. By the beginning of day 3, after 48 hours without sleep, the increase in errors on the perceptual-motor task is 120 percent of baseline.

The second figure shows the recommended hours of recovery (sleep and relaxation) for varying periods of continuous work without sleep. Notice that after four days (96 hours) of continuous operations, a recovery period of five days is recommended for complete recovery.

Implications

The implications of Figure 3.18 are that as sleep loss accumulates, perceptual-motor performance and perceptual speed will be impaired. Route markers may need to be two to three times more visible, in terms of size or brightness, for a soldier who has not slept for two or three days than for a well-rested soldier.

Figure 3.19 gives the recommended rest periods for complete recovery. The suggestion is that if first echelon troops fight, say, for four days, they will need a five day recovery period before they can be used with full effectiveness. Rotation plans should be based, in part, on this consideration.

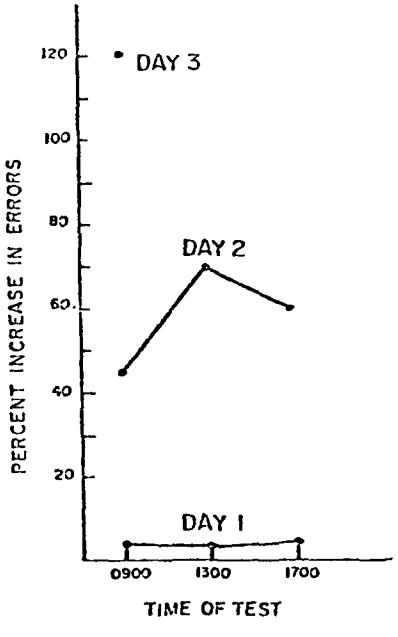


Figure 3.18. Perceptual motor skill over a 48 hour period without sleep.

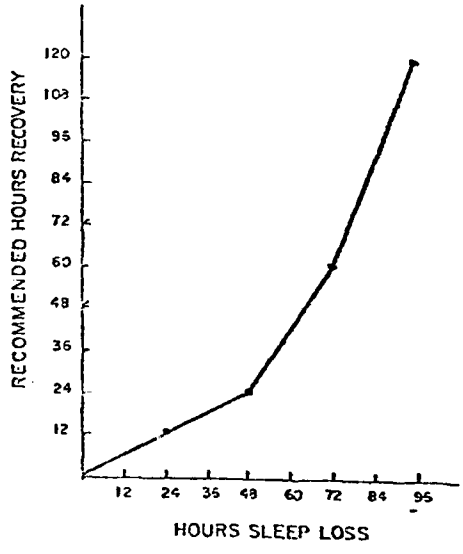
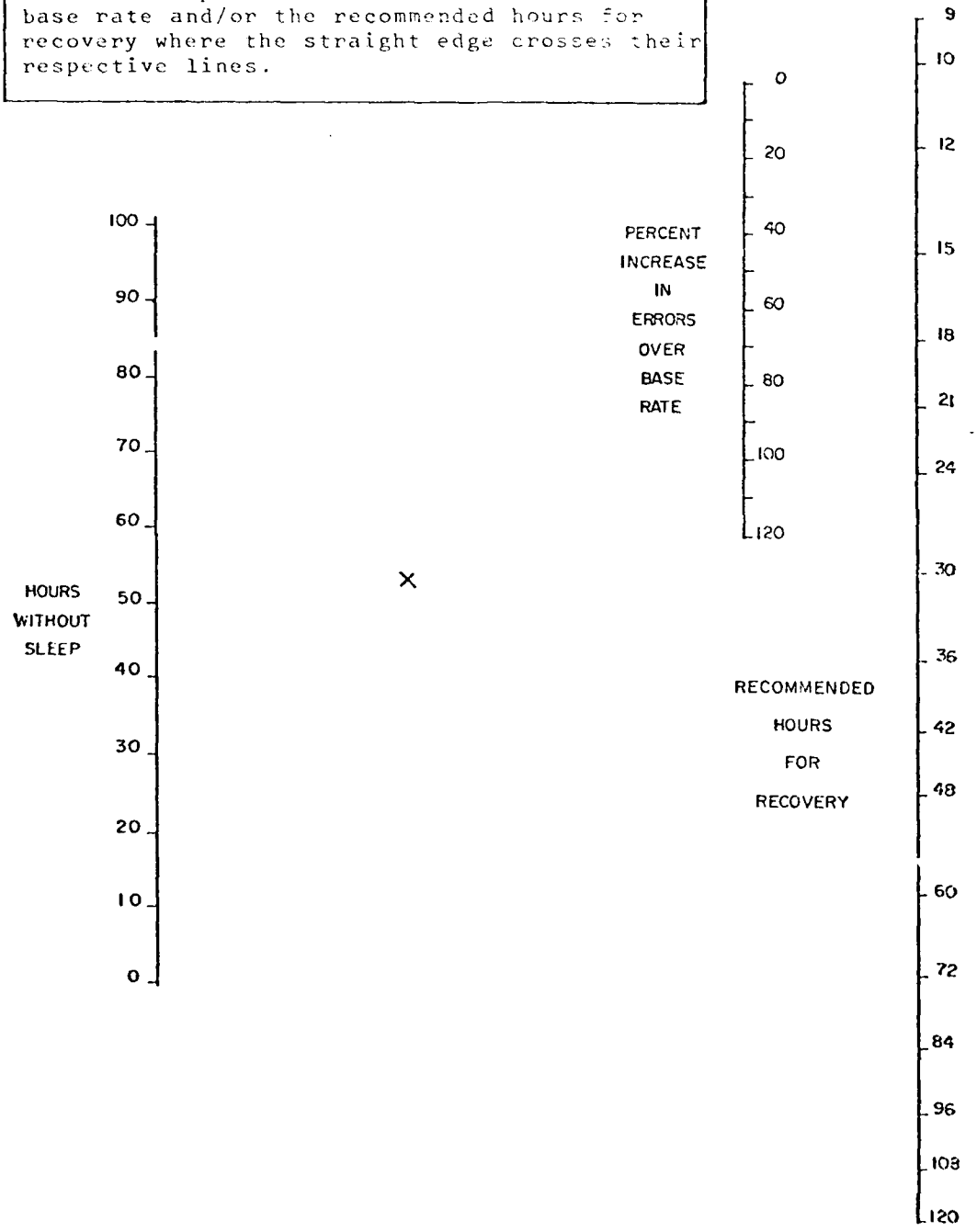


Figure 3.19. Recommended hours of recovery as a function of sleep loss.

DIRECTIONS

1. Select hours without sleep.
2. Align a straight edge with this value on its line and the center of the "X."
3. Read the percent increase in errors over base rate and/or the recommended hours for recovery where the straight edge crosses their respective lines.



Nomograph showing error rate and recommended rest time as a function of hours without sleep.

CRITICAL TASK 30

Position: Maneuver Team Member

Task: Fire While Relocating

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Dynamic Precision	Light Level/Visibility	18, 20
Memory	Stress	56, 69

DISCUSSION

This task involves shooting at targets that have a brief and unpredictable exposure. Figure 3.20, based on British data, shows that the mean number of hits deteriorates rapidly with sleep loss. The score recorded for each soldier was the number of hits out of a total of nine. Portable electric targets, at ranges of 100m, 200m, and 300m from the firing point, were exposed for 5 seconds at time intervals varying between 10 seconds and 7 minutes. Each man had an arc of fire of 622 mils. Accordingly, the soldiers required vigilance to detect the target. The three goups received no sleep, 1.5 hours, and 3 hours sleep per night respectively. All groups recovered after three days of rest.

Interpretation

The figure shows that the number of hits deteriorates rapidly with sleep loss. An interesting question is whether as the shooting skill deteriorates, the attention capacity of the soldier deteriorates, or a combination of both produces the effect. Separate tests of grouping capacity (while shooting at predictable targets) suggest that it is the vigilance for unpredictable targets which deteriorates with sleep loss.

The two sets of results differ because one set is based on a self-paced task (shooting at predictable targets) and the other set is an environmentally-paced task with a high vigilance component (shooting at an unpredictable target). While vigilance is sensitive to sleep loss, well learned tasks resist sleep loss. Figure 3.21 presents the results for predictable targets. Here sleep loss has no influence on the ability of soldiers to group their shots. One can not expect soldiers to remain vigilant for more than 20 minutes at a time.

Accordingly, fire rate must be increased as the continuous operation time increases, if the kills are to remain constant. Less reliance should be placed on first shot hit.

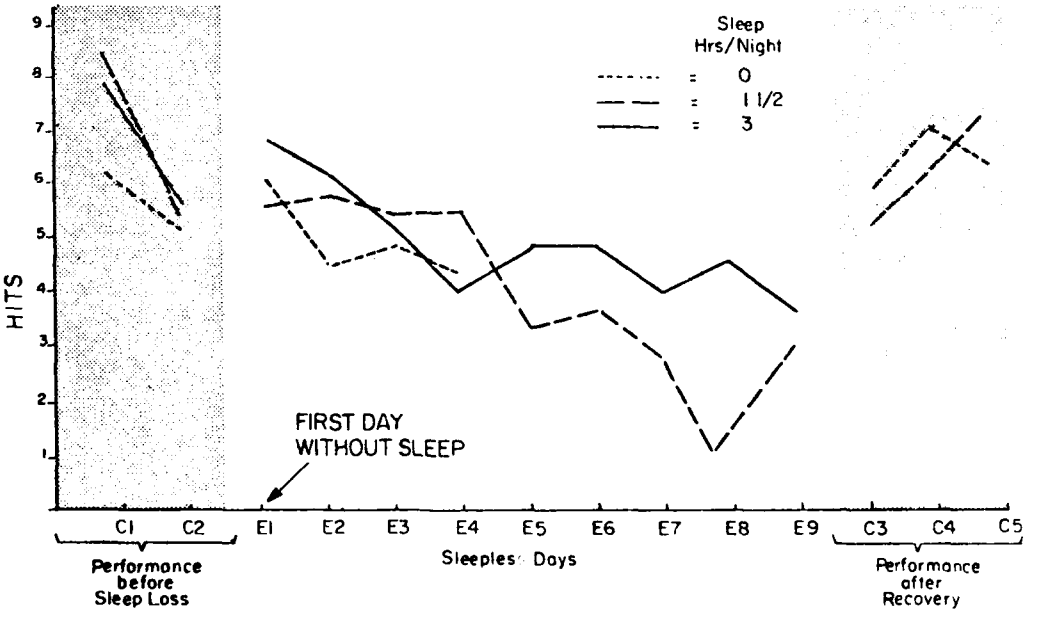


Figure 3.20. Vigilance shooting under varying conditions of sleep loss

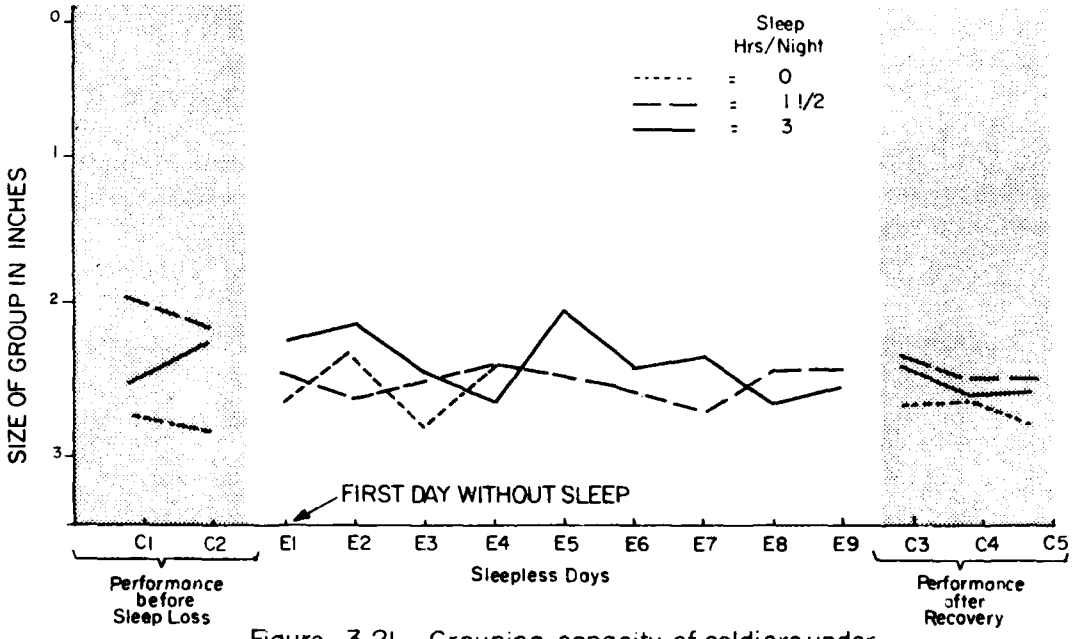


Figure 3.21. Grouping capacity of soldiers under varying conditions of sleep loss

CRITICAL TASK 31

Position: Maneuver Team Member

Task: Move To Assembly Area

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Orientation	Light Level/Visibility	7

CRITICAL TASK 32

Position: Maneuver Team Member

Task: Fire To Cover Move To Assembly Area

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Memory	Stress	56, 69

CRITICAL TASK 33

Position: Squad Leader

Task: Observe Terrain For Enemy Presence

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6

DISCUSSION

In continuous operations, the Squad Leader will spend a great deal of time determining whether or not the enemy is present. The Leader will use all of his senses, aided and unaided, as the situation requires. The following discussion shows the effects of fatigue on detection, and the advantage of multiple sensory input in this regard.

Detection

During the hour watch that was studied, the detection of visual signals was greatly impaired. Detection dropped nearly 20 percent over the hour. Detection of auditory signals was impaired by less than 10 percent. And, detection of combined auditory and visual signals was impaired less than 5 percent. An important feature is that, in all cases, combined auditory and visual signals were more frequently detected than by either sense alone.

In general, the human perceptual system relies heavily on *intersensory co-operation*. That is, we confirm information received by one sense, such as vision, by comparing it with information received by another sense, such as audition. For example, an approaching tank not only presents a visual target, but it also makes noise. When an approaching tank is camouflaged and in darkness, its visual projection alone may not be sufficient to assure detection. But when the noise of its engines and tracks accompany the near threshold visual projection, the tank's probability of being reported rises sharply.

Implications

The implications are:

1) fatigue will cause a decrement in the ability to detect targets

2) fatigue will have a greater decrement on the visual detection of targets than on the auditory detection of targets

3) the detrimental effects of fatigue are dramatically offset by intersensory validation.

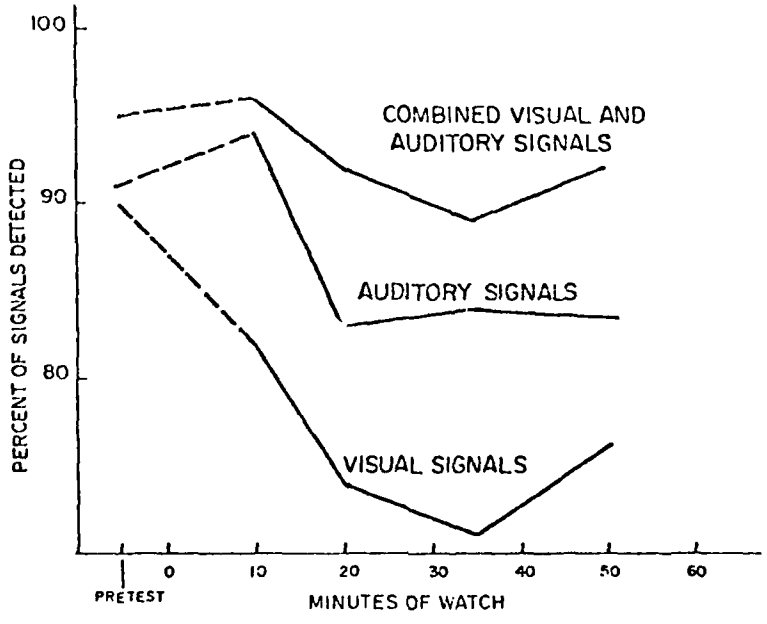
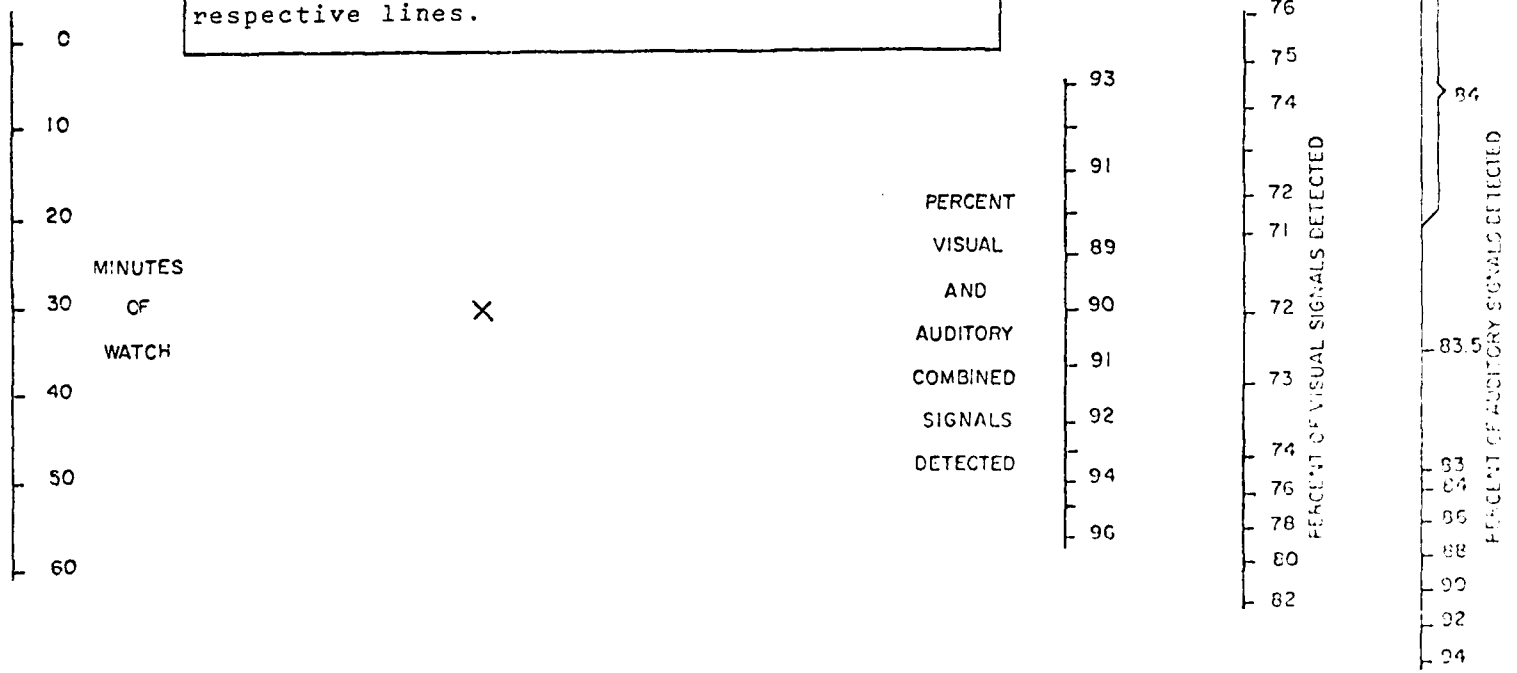


Figure 3.22. Effects of fatigue on detection for vision, hearing, and combined vision and hearing.

DIRECTIONS

1. Select minutes of watch.
2. Align a straight edge with this value on its line and the center of the "X."
3. Read the percent signals detected for auditory, visual, and/or visual and auditory combined where the straight edge crosses their respective lines.



Nomograph for determining detection performance as a function of watch length.

CRITICAL TASK 34

Position: Squad Leader

Task: Establish Communications Network

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 35

Position: Squad Leader

Task: Identify TRPs

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 36

Position: Squad Leader

Task: Prepare Range Cards

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The *performance* of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythms	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythms	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 37

Position: Squad Leader

Task: Establish Routes To Subsequent Positions

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 38

Position: Squad Leader

Task: Supervise Obstacle And Camouflage Construction

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74

CRITICAL TASK 39

Position: Squad Leader

Task: Adjust Firing As Necessary

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 40

Position: Squad Leader

Task: Coordinate Squad Relocation If Necessary

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 41

Position: Squad Leader

Task: Direct Relocation Fire

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 42

Position: Squad Leader

Task: Make New Range Cards As Needed

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 43

Position: Squad Leader

Task: Direct Movement To Assembly Area

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	Fatigue	1, 30, 33
Numerical Facility	Diurnal Rhythm	11, 57, 61
Reasoning	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69
Co nmunication	Stess	48

CRITICAL TASK 44

Position: Squad Leader

Task: Direct Cover Fire While Moving To Assembly Area

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Numerical Facility	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Memory	Stress	56, 69
Communication	Stress	48

DISCUSSION

This task involves scanning wide areas under varying light levels in order to detect enemy presence and friendly element locations. Many factors operate to limit the ability to see under low light levels. One of the most important factors is the structure of the eye itself. The part of the eye that gives us our best vision can only operate at light levels equivalent to a full moon over snow or brighter. Below that light level, because the most sensitive part of the eye can no longer respond, the part of the eye that responds is about 30^{o} to the outside of straight ahead. Figure 3.23 shows how vision in the retinal area and other areas compares with vision in good light in the most sensitive region of the eye.

Interpretation

The figure shows how acuity decreases as an object is presented at varying degrees from the area of maximum sensitivity. Notice that at 30^{o} toward the ear, acuity is less than 10 percent of its maximum. Stated in another manner, an object which can just be seen at the point of maximum night vision sensitivity must be more than 10 times as large as it need be in daylight as seen by the fovea, the area of maximum sensitivity of the eye.

Implications

The implications of the relationship shown are very straightforward. Detail vision is poor at night. When the light level is below that of a full moon on snow, vision is one tenth as good as in the daytime. All visual detail to be detected must be 10 times as great. For the Squad Leader (and for everyone using unaided vision), the task of detecting the enemy by unaided vision is at least 10 times more difficult.

One can increase the probability of detection by moving the eyes frequently. Training is indicated in this regard. But, if successful execution of this task requires performance near daytime levels, the use of a night vision device is imperative. Devices ranging from night vision goggles or scopes to flares, or even a pair of binoculars, will assist in overcoming the diminished vision.

The observer can also position himself to best advantage and should be trained to find positions which allow silhouetting of potential targets or maximize the contrast of a potential target with its background. An example of the latter suggestion would be positioning oneself so that the approach of enemy elements would be viewed against a background of ripened wheat rather than a cluster of trees, thus increasing the brightness contrast of the target and background.

It is also imperative that ovservers be dark adapted and remain so. Full dark adaptation takes a minimum 20 minutes.

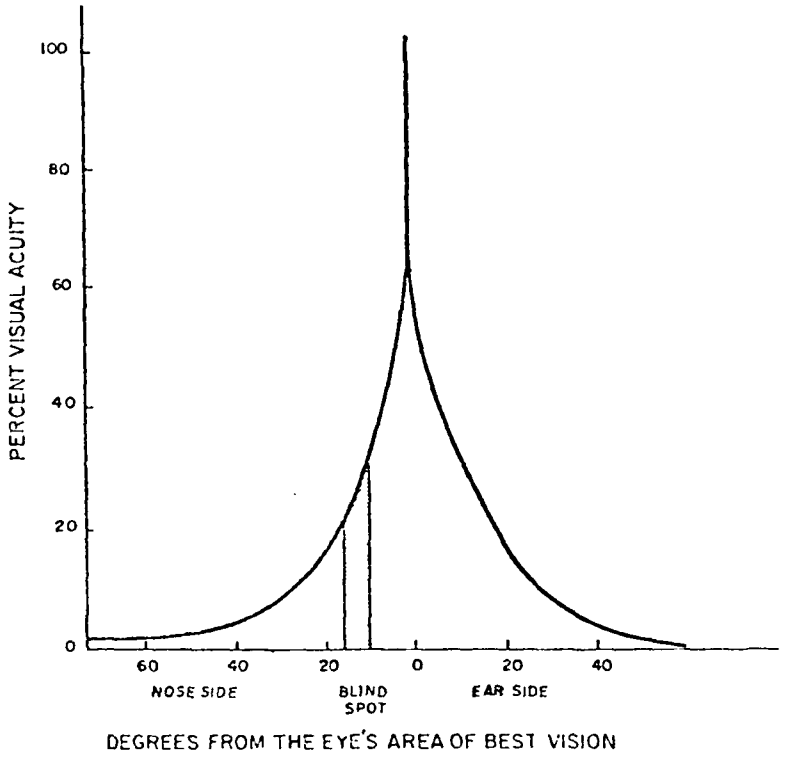
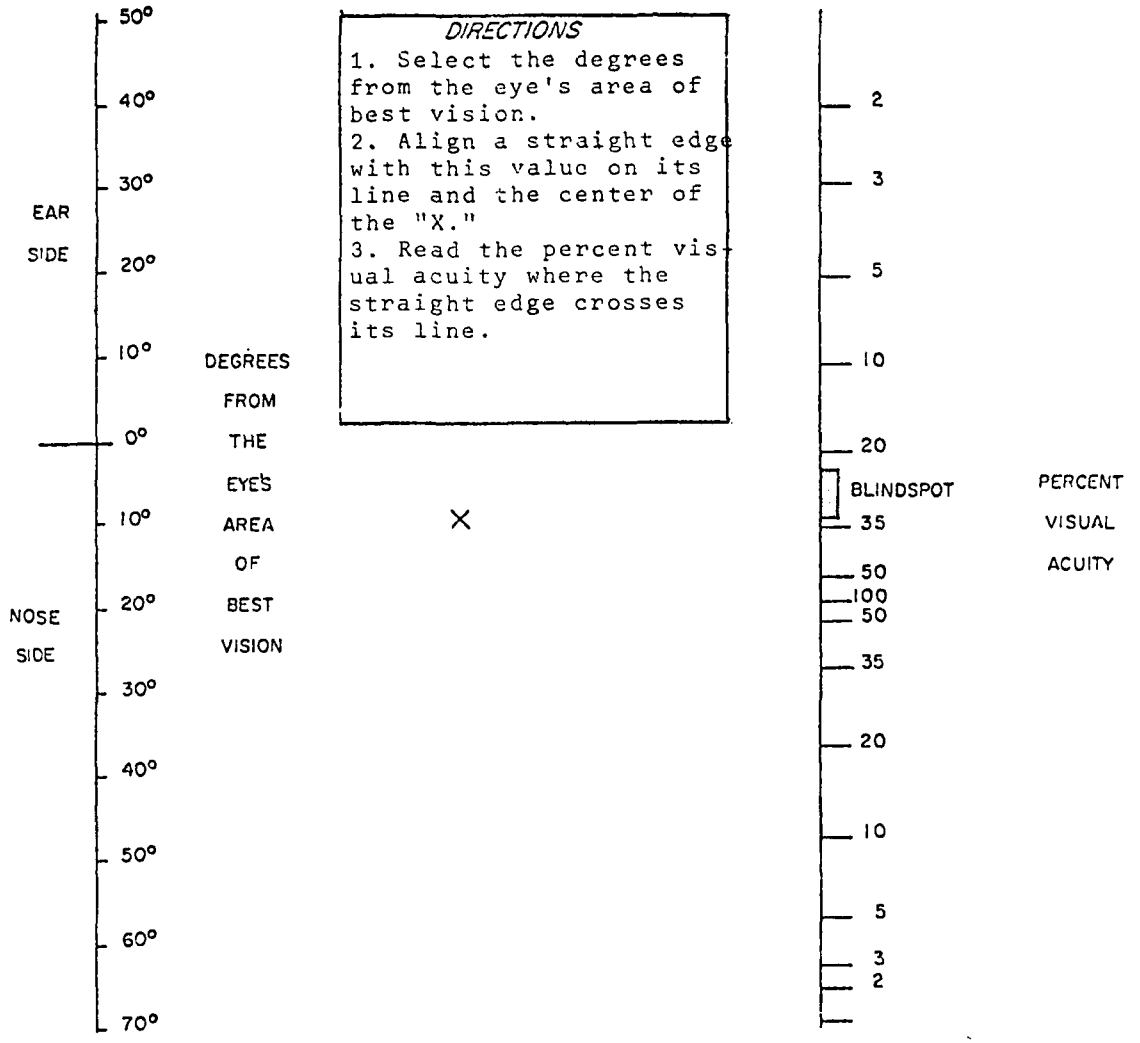


Figure 3.23. The ability to detect detail in objects looked at off-center (as is necessary at night).



Nomograph showing relative visual acuity as a function of angle from area of best vision.

CRITICAL TASK 45

Position: Squad Leader

Task: Assign Exposed Fire Team As Needed When Mounted

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74

DISCUSSION

The Squad Leader will direct the mounted fighting of his squad under conditions, at times, in which he is exposed to long periods of high temperature and/or high humidity. The Squad Leader will make important decisions on the basis of a considerable amount of information. In the presence of certain heat and humidity conditions, the Squad Leader's ability to make these decisions will be impaired. Figures 3.24 and 3.25 show this relationship.

Interpretation

Figure 3.24 is the one of importance here. Before the figure can be used effectively, the concept of effective temperature must be introduced. Figure 3.25 shows effective temperature lines, which depend on temperature and relative humidity. All points on a given effective temperature line are perceived as being the same temperature. That is, they have the same behavioral effect. As an example, an air temperature of approximately 89°F at 60 percent relative humidity and 75°F at 100 percent relative humidity. The temperature sensed at 100 percent relative humidity is the numerical value given the effective temperature which is felt at other levels of relative humidity. Accordingly, 110°F at 100 percent relative humidity is 110° ET (Effective Temperature).

Figure 3.24 shows the upper limit of unimpaired mental (i.e., cognitive) performance as the effective temperature at which mental performance will remain unimpaired for the duration of time indicated. As an example, at 90°ET, mental performance will be unimpaired for exposures to this effective temperature of two hours or less. Beyond two hours, mental performance will be impaired. Note first that for periods of time in excess of four hours, 85°ET seems to be the upper limit. Note also that mental performance impairment is reached before the tolerable physiological limit is reached. This limit is the maximum combination of exposure time and effective temperature for a typical person.

Implications

The Squad Leader will have difficulty making decisions when he is exposed to effective temperatures in excess of 85° for prolonged periods of time. These temperatures may often be found during mounted combat. The two appropriate responses to this difficulty are:

(1) anticipate the impairment and provide decision aids and information processing aids to help compensate

(2) make every effort to provide an environment during mounted combat which does not exceed 85°ET for periods of time that result in decreases in mental performance.

The second goal can be achieved by any of the following. Tactics and procedures should be developed to allow, where possible, frequent dismounting (at least once per hour). Light clothing, drinking water, fans, and other aids to reducing body temperature should be liberally employed.

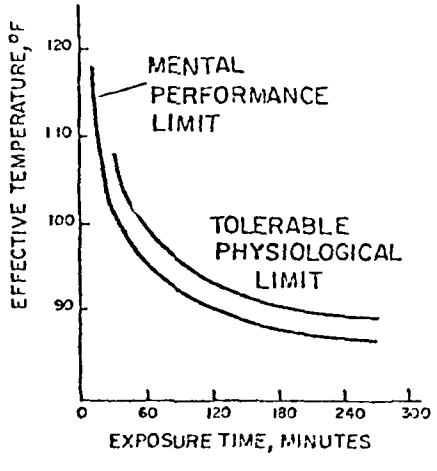


Figure 3.24. Upper limit of effective temperature for unimpaired mental performance and physiological limit as a function of exposure time.

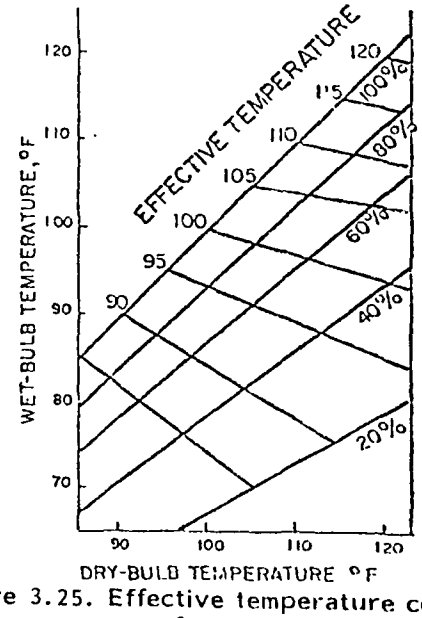
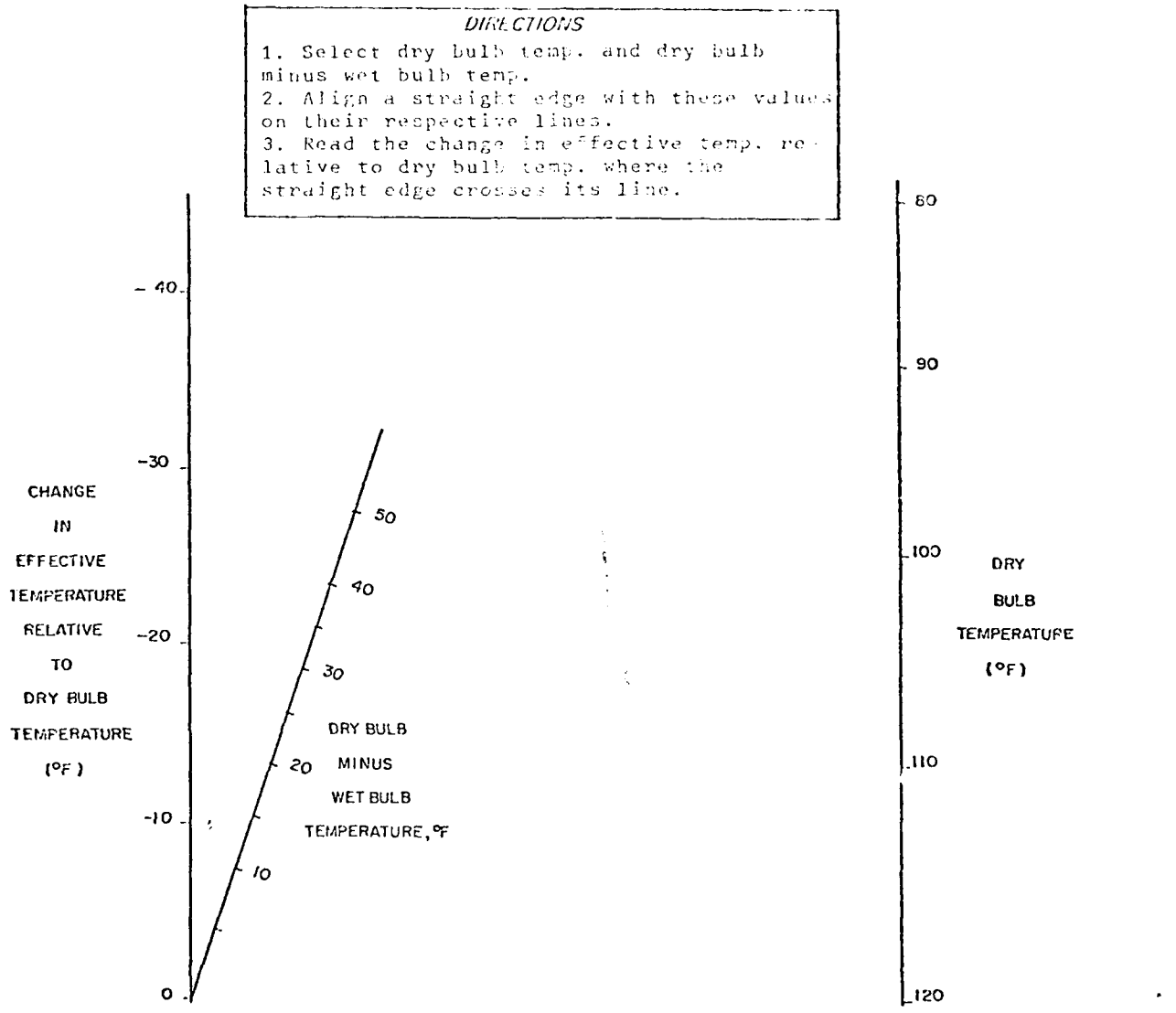


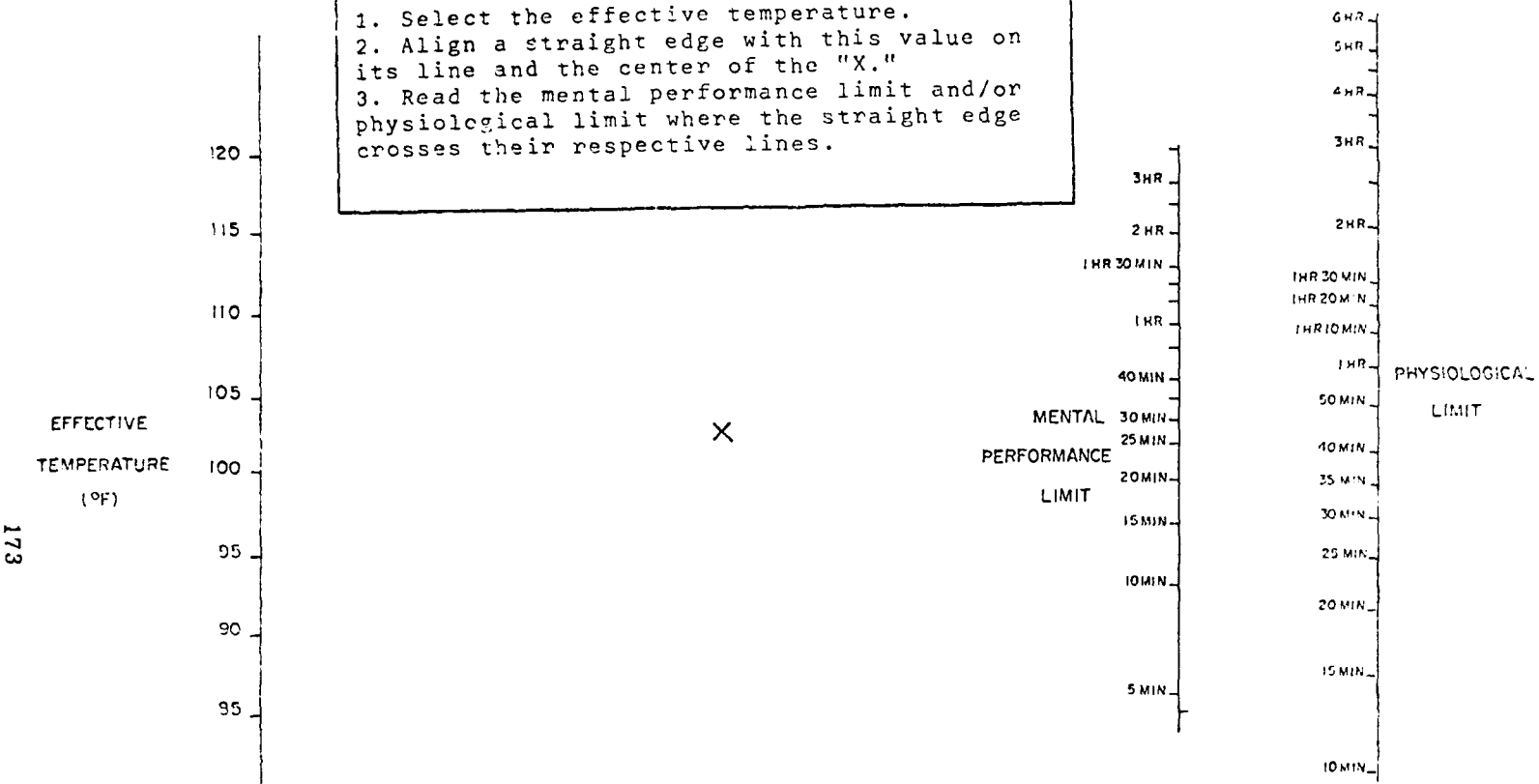
Figure 3.25. Effective temperature contours as a function of temperature and relative humidity, little air movement.



Nomograph for deriving effective temperature.

DIRECTIONS

1. Select the effective temperature.
2. Align a straight edge with this value on its line and the center of the "X."
3. Read the mental performance limit and/or physiological limit where the straight edge crosses their respective lines.



Nomograph showing maximum time for mental and physiological functioning as a function of effective temperature.

CRITICAL TASK 46

Position: Squad Leader

Task: Coordinate Fire Needs Per PL Instructions While Mounted

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 47

Position: Squad Leader

Task: Direct Squad Movement During Disengagement

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level Visibility	7
Communication	Stress	48
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 48

Position: Squad Leader

Task: Communicate With PL During Disengagement

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Vision	Light Level/Visibility	9, 26, 44, 72
Communication	Stress	48

DISCUSSION

This task requires the SL to communicate vital information to the PL during disengagement. Part or all of this communication is unaided verbal communication. On a night which is darker than a night with a full moon over snow, or in dense smoke, fog, or mist, visual cues will be limited. Background noise will interfere further with communication. Figure 3.26 shows the amount of interference as a function of the distance between the speakers and the listener and the intensity of common sounds.

Interpretation

The amount of interference will be greater as the distance between the SL and PL increases. Even when shouting, a separation of 40 feet is enough to allow a noise of only 50 decibels (db) to prevent full communication. Note that 50 db at 40 feet is less loud than a conversational voice at five feet. On a decibel scale of sound pressure, any addition (or subtraction) of six db represents multiplication (or division) of the sound level by two. A difference of 20 db represents a factor of 10.

Implications

The major implication to be drawn here is that the SL will probably be unable to communicate effectively with the PL if the separation is more than a few feet. If radio communication or communication with visual signals is possible, the problem is averted. More typically, and in the present scenario, it may be necessary to avoid visual signals or radio signals which may reveal the disengagement route. The most logical solution is well-thought out SOPs which lessen the need for communication. Written communication might also be considered under these conditions. Another solution is to supplement or replace verbal communication with sign language. Finally, some other form of communication could be employed such as an electrocutoneous command signal language.

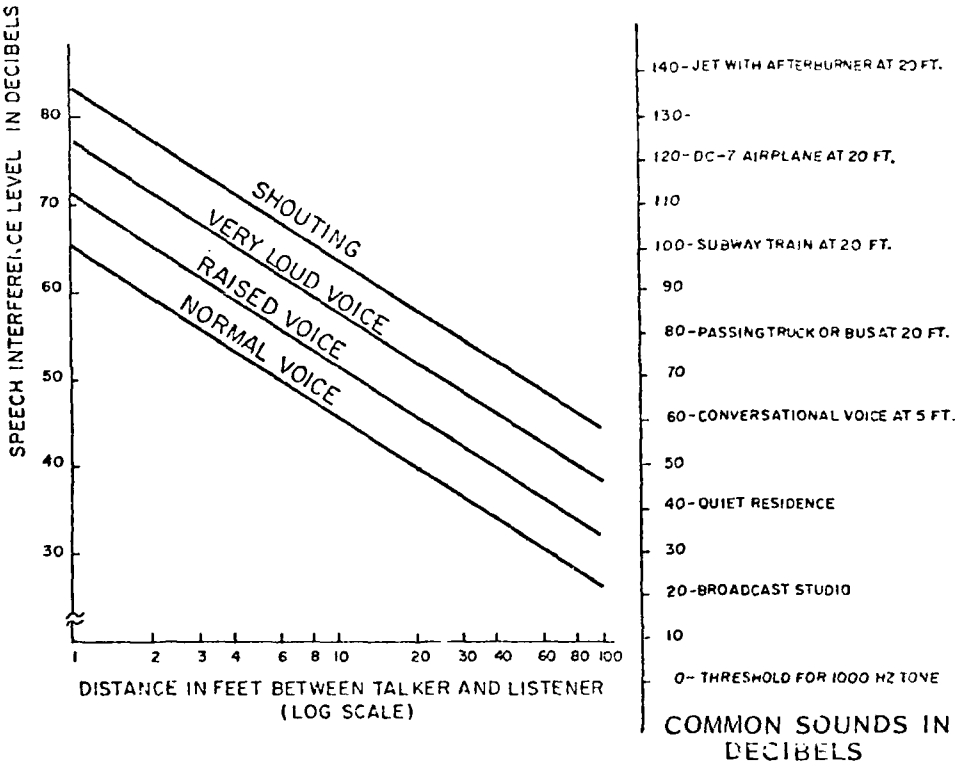
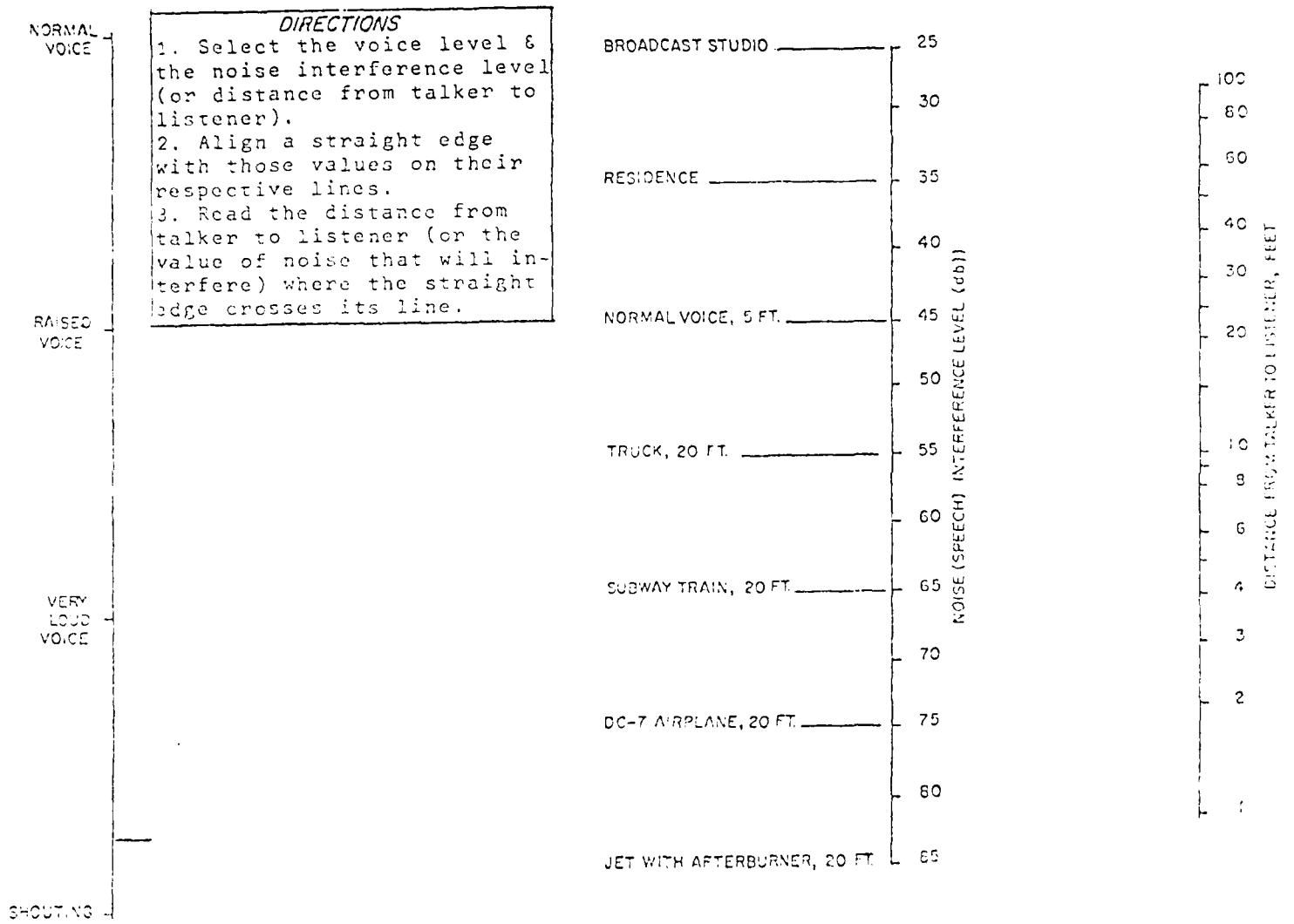


Figure 3.26. Minimum allowable interference levels from noise.



Nomograph showing distance at which various voice levels may be heard in noise.

CRITICAL TASK 49

Position: Squad Leader

Task: Direct Proper Movement To Regrouping

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 50

Position: Platoon Leader

Task: Conduct Reconnaissance

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Light/Visibility	7
Numerical Facility	Diurnal Rhythm	11, 57, 61
Reasoning	Diurnal Rhythm	11, 57, 61
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 51

Position: Platoon Leader

Task: Check Accuracy of Terrain Maps

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Stress	2, 6

CRITICAL TASK 52

Position: Platoon Leader

Task: Check On Support Fire Availability

Highly Critical in Platoon Actions:

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	None	

CRITICAL TASK 53

Position: Platoon Leader

Task: Decide To Engage Unexpected Fire Or Not

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74

DISCUSSION

The PL will often be required to make decisions and analyze information under less than ideal conditions. During continuous warfare, the PL will be exposed for long periods of time to varying levels of noise. Much of the noise, such as gunfire, will be intermittent. As for other abilities, noise will contribute to deterioration in reasoning ability. Figure 3.27 shows the effects of noise on the ability to think and make decisions.

Interpretation

Noise has many dimensions. Figure 3.27 shows how noise affects reasoning when it is either loud (108 db) or soft (56 db). The loud noise is nearly 400 times louder than the soft. Noise can also be predictable or unpredictable. The ordering of the effects is quite clear. Unpredictable noise has the greatest detrimental effect. A loud noise can degrade reasoning dramatically. In this case it caused an error rate increase on the mental task from 27 percent to 42 percent. A soft unpredictable noise (and 56 db is not much more than half as loud as a conversational voice) is more disturbing than a loud, predictable noise.

Implications

Once again, one of the main implications is awareness of the problem. The battlefield will provide a great deal of intensely loud and unpredictable noise in the form of enemy fire, aircraft, and vehicular sounds. Knowing that this will offset reasoning is a forewarning.

Other possible considerations are the following:

(1) well-developed SOPs, which circumvent the need for decisions

(2) noise insulation devices should be worn when possible

(3) training under noise conditions which simulate actual battlefield conditions

(4) development of decision aiding devices

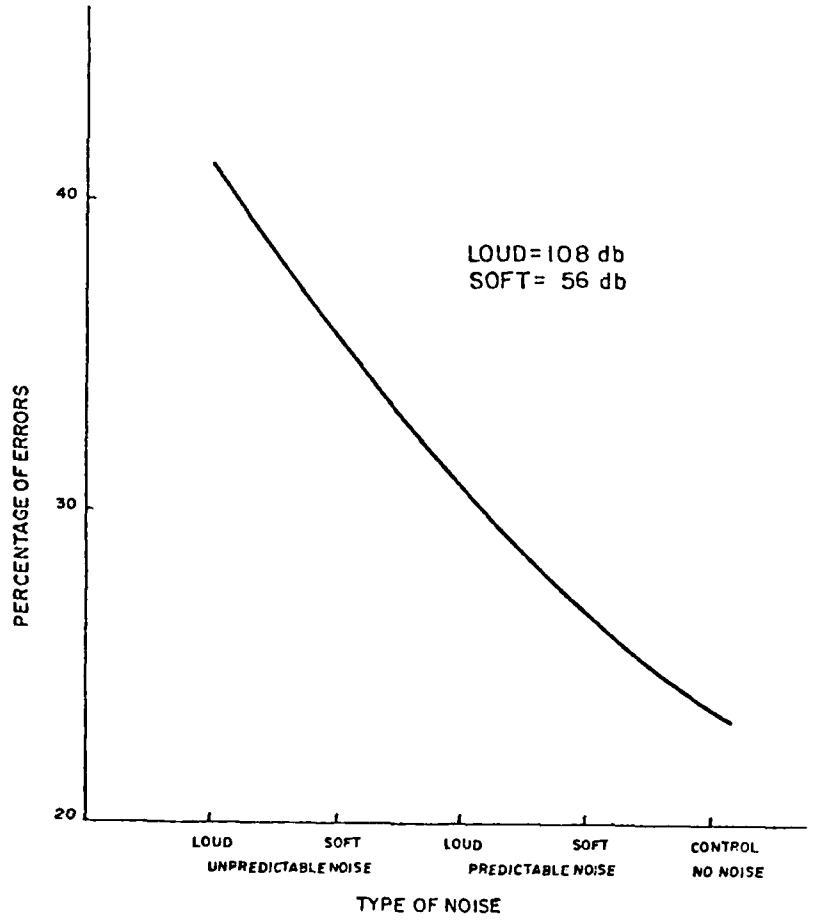


Figure 3.27. After effects of predictable and unpredictable noise on mental performance.

CRITICAL TASK 54

Position: Platoon Leader

Task: Direct Mounted Defense

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 69, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69
Communication	Stress	48

DISCUSSION

The direction of a mounted defense by the Platoon Leader requires integration from several sources. At times, the Platoon Leader will be required to process information from more than one source at the same time. His ability to do so will be less than his ability to process information from a single source. Figure 3.28 shows the effect of time-sharing in this sense.

Interpretation

Figure 3.28 shows the effects of divided attention, that is, the difference in the probability of correctly interpreting a message (in this case delivered to the ear) when the listener was required to attend to either one channel alone (one ear) or to two channels (both ears). The form of data presentation in the graph is called an ROC curve (for Receiver Operating Charateristic curve). When data are presented in such a fashion, a difference in the ability to perceive and report a message accurately as a function of how well the message is received is reflected in the difference in location of the curves being compared. The closer the curve is to the upper left of the graph, the better the message is received. It is quite clear that the divided attention curve reflects poorer message reception and reporting than the single channel curve legended "control."

Without going into highly theoretical detail, each curve, by itself, shows that for a message of a given intensity (e.g., loudness in the present case), the listener's information processing also depends on other judgmental factors. The result is that as the listener's proportion of correct reports increases because of these judgmental factors, his proportion of false reports also increases. The judgmental factors are often referred to as the bias.

Implications

The major conclusion to be drawn is that as the intensity of the defense increases, thereby forcing the PL (or anyone receiving and processing information in order to make decisions) to attend to two or more sources of information simultaneously, the correct perception of the information will decrease. The further conclusion is that for any given level of information sensitivity, i.e., the clarity of a particular message for a particular receiver, the bias of the receiver will affect his probability of correct processing of the message. The exact bias will have the effect of raising or lowering both the probability of correct message processing and incorrect message processing simultaneously.

The methods of dealing with this problem include providing training in processing multiple information sources simultaneously such that sensitivity (and/or ability) increases and the receiver learns the optimal bias to achieve specific goals. Field training or case method training would be ideally suited to this end.

Methods of economically presenting information, storing information, and sharing the information handling duties among members such as the PL, SL, and assistant SL will all aid in reducing the difficulties associated with the problem of divided attention.

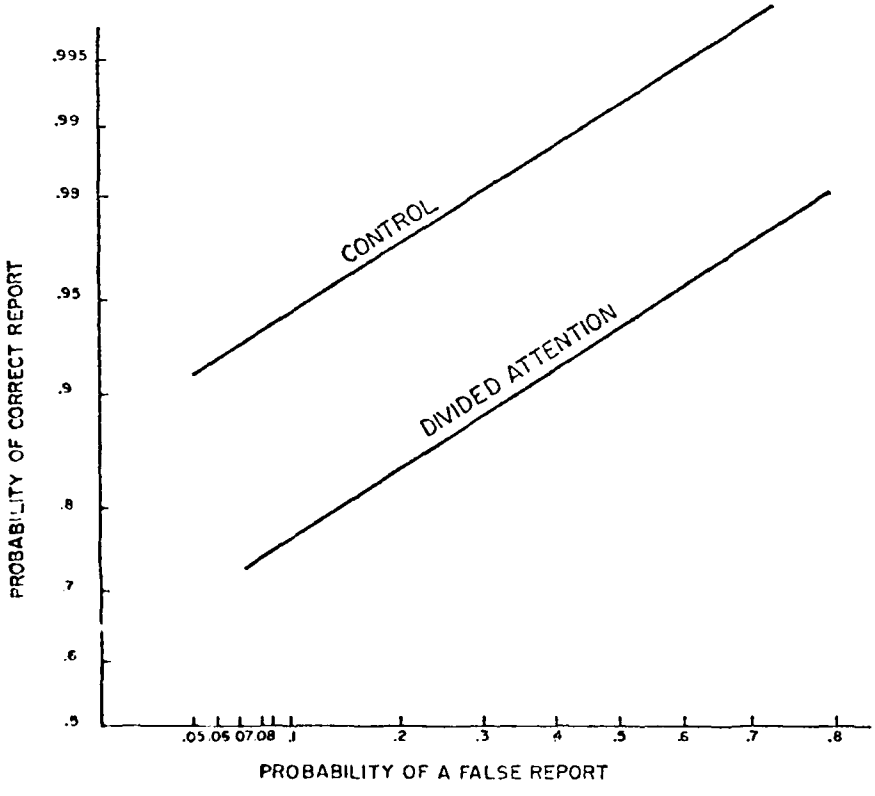


Figure 3.28. Effect of dividing attention compared with a single information source.

CRITICAL TASK 55

Position: Platoon Leader

Task: Communicate With OP's

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 56

Position: Platoon Leader

Task: Request Possible Support Fire Requirements From Company

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69

DISCUSSION

The Platoon Leader's execution of this task involves remembering a great deal of information, including codes, coordinates, locations of various elements, and a host of other variables. Memory is an important ability for many tasks and is exemplified in this task. The need to recall codes, SOPs, and other facts will be a crucial element in night/continuous operations. Memory is so highly complex that only very broad, general statements can be made in this Guidebook. The present relationships concern recalling such information as codes and the effects of mission duration and practice on the memory for such learned material.

Interpretation

Figure 3.29 concerns overlearning and how overlearning is related to recall. Overlearning is frequent rehearsal of material even after it has been learned flawlessly. The amount of time or number of rehearsals to reach the level of a flawless recitation is the "no overlearning" condition. Some people in the study from which the graph was taken were required to practice what they had memorized perfectly for as much time as it took initially to master the material. This is the "100 percent overlearning" condition. The curves on the left show how much was remembered at varying numbers of days after the learning day and clearly shows the advantage of overlearning. The curves on the right show the percentage of the original learning time required to relearn material after varying numbers of days. Once again, the overlearning group is clearly superior and retains more material over a longer time.

Figure 3.30 shows how something practiced each day for six days to the point of mastery requires less practice each day. In a sense then, something practiced to mastery every day is a form of overlearning.

The figures combined clearly show that overlearned material will be remembered for longer periods of time.

Implications

The implications for continuous operations are that information that must be recalled under stress should be overlearned. The overlearning can be greater than 100 percent. But the improvement will not be much better than with 100 percent overlearning attempted at one sitting. However, if the overlearning can be engaged in by troops in, say, a second echelon who may have several days to practice, their retention will be outstanding, as suggested by Figure 3.29.

The problem with attempting to describe the constraints on memory in a setting such as this is the large number of variables which affect memory and the phenomena which are associated with memory. The best solution to considering the implications of continuous operations and memory as an ability required in many tasks is an evaluation of each task in terms of the type of information to be remembered, the complete set of conditions under which it is to be remembered and learned, and the history and training of the people involved with respect to the information to be remembered. Following this evaluation, programs for developing memory aids, training, and appropriate cueing material could be developed.

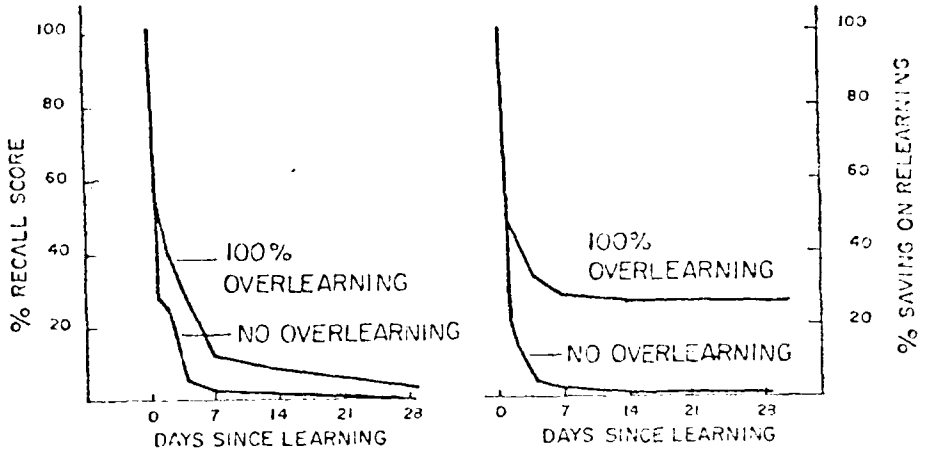


Figure 3.29. Percentage recall (left curves) and percentage of learning trials to relearn (right curves) for criterion of one correct trial (no overlearning) and twice that learning period (100% overlearning).

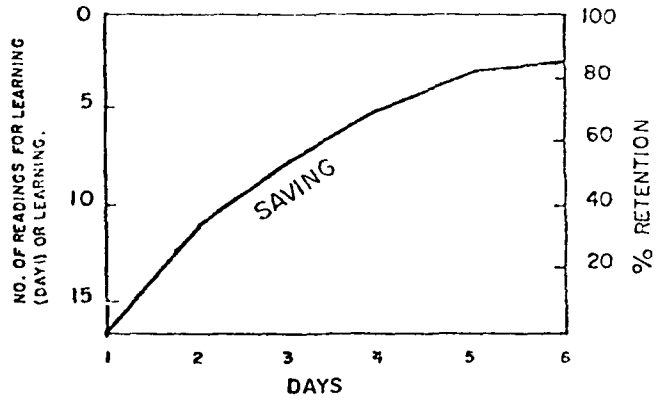
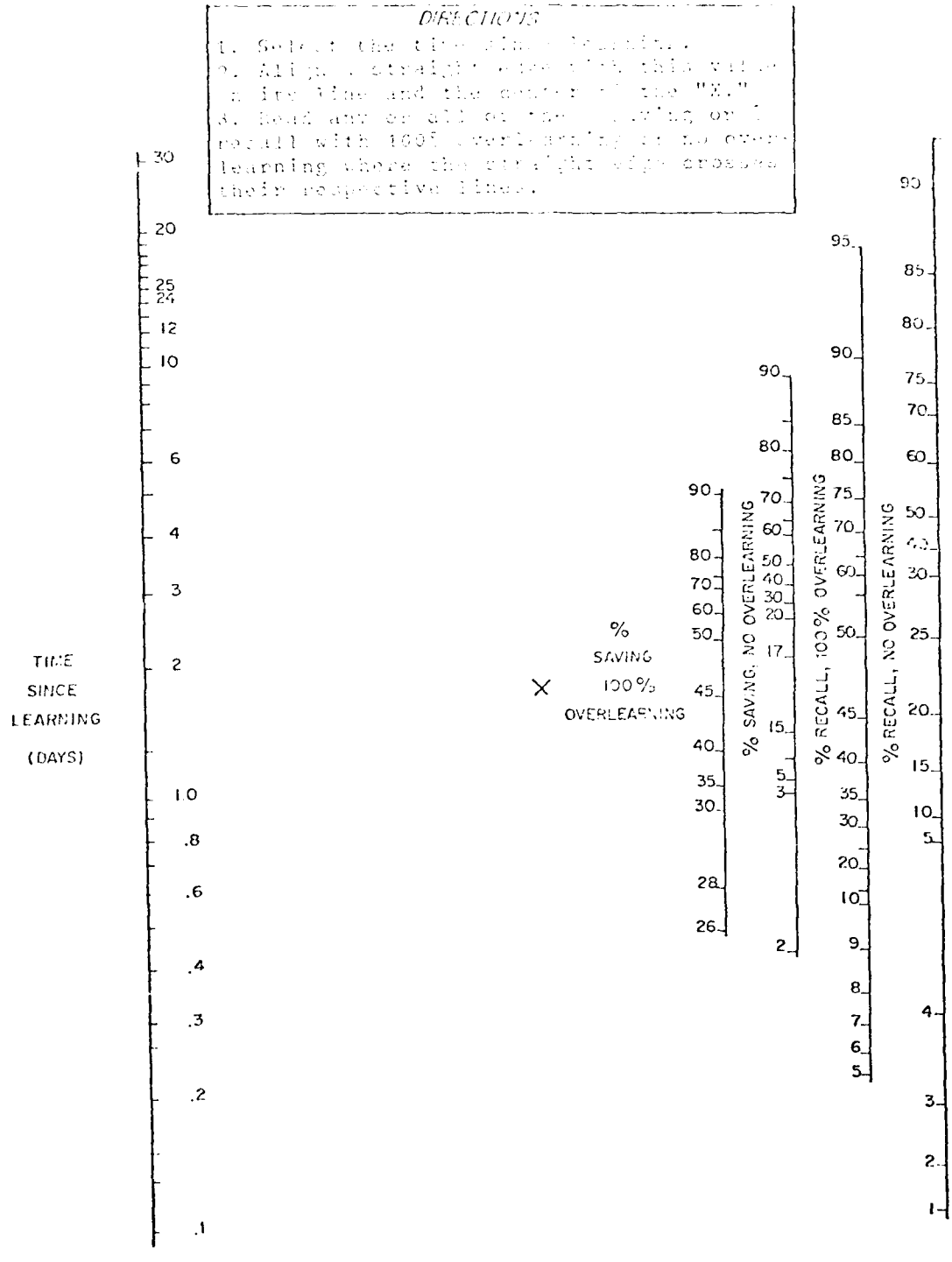


Figure 3.30. Saving, that is, the reduction in relearning time (increase in retention) over time.



Nomograph showing relearning and recall as a function of time since learning.

CRITICAL TASK 57

Position: Platoon Leader

Task: Select Positions For Cover, Concealment From Observation, And Fire

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
Vision	Light Level/Visibility	9, 26, 44, 72
Communication	Stress	48

DISCUSSION

In selecting positions for cover, concealment from observation, and fire, the PL Leader must take advantage of every rock, tree, fold in the terrain, and of all rubble and abandoned equipment. He insures that each position has cover and concealment and at the same time, has a good field of fire to cover assigned sectors of fire. If natural cover is not available he must construct frontal parapet foxholes. Perceptual speed represents one critical ability required for performing this task.

Interpretation

Perceptual speed has been found to be sensitive to the combined effects of diurnal rhythms and sleep loss with performance worst between 0300 and 0700 hours. In a British test, perceptual accuracy was assessed as a function of sleep loss. The test was carried out between 0200 and 0700 hours and showed a significant deterioration with sleep loss and diurnal rhythms. The adverse affect was particularly severe for the group totally deprived of sleep (Figure 3.31). On a self-demand sleep schedule, all groups recovered after two days of rest.

To overcome the problem one might employ task rotation among crews highly trained to shift functions or employ periodic breaks with mild physical exercise.

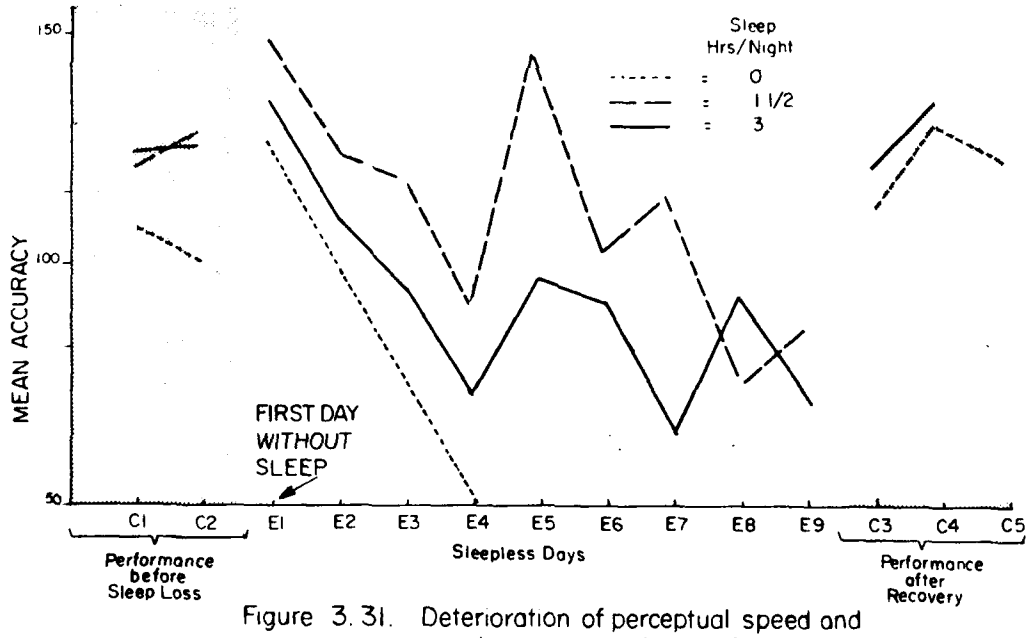


Figure 3.31. Deterioration of perceptual speed and accuracy under varying conditions of sleep loss

CRITICAL TASK 58

Position: Platoon Leader

Task: Establish Inter-Squad Communication Network

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74

CRITICAL TASK 59

Position: Platoon Leader

Task: Assign Locations To SLs

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 60

Position: Platoon Leader

Task: Establish TRPs

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69

CRITICAL TASK 61

Position: Platoon Leader

Task: Assign Fire Zones and Targets

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Light Level/Visibility	7
Communication	Stress	48

DISCUSSION

The assignment of fire zones and targets, which is partially dependent on reasoning and numerical ability, needs to be performed at various times during a continuous operation and under various states of fatigue. Evaluating fatigue, even as a function of sleep loss, is a problem since the PL and other soldiers may find opportunities for rest. The effect of fatigue due to lack of sufficient continuous sleep and the disruption of diurnal rhythms (behaviors engaged in typically on a 24-hour basis) are difficult to assess. Figure 3.32 helps to provide an understanding of these problems.

Interpretation

This figure is drawn from a study which involved 15 days on a four hours on-two hours off work schedule. The curves represent five day averages. For this group of people, there was a peak in performance between 2000 and 2200 hours the first five days and the disrupted schedule caused the peak to shift slightly. More importantly, the disruption of diurnal rhythms led to progressively poorer performance. If the individual curves for days were strung out over a 15 day period, one would see a decreasing curve reflecting a continuously degraded performance. The 15 day curve would show peaks at around 2200 each night, but each peak on each succeeding day would be lower as would the performance on each day.

Implications

In continuous operations, numerical facility and mental performance in general will deteriorate with the disruption of diurnal rhythms. Note that the four on - two off work cycle allows for sleep one-third of the day. Yet, performance deteriorated. Not much can be done to correct for deficiencies introduced by the disruption of diurnal rhythms. Well reasoned SOPs and echelonment where possible which allows normal diurnal activity would help.

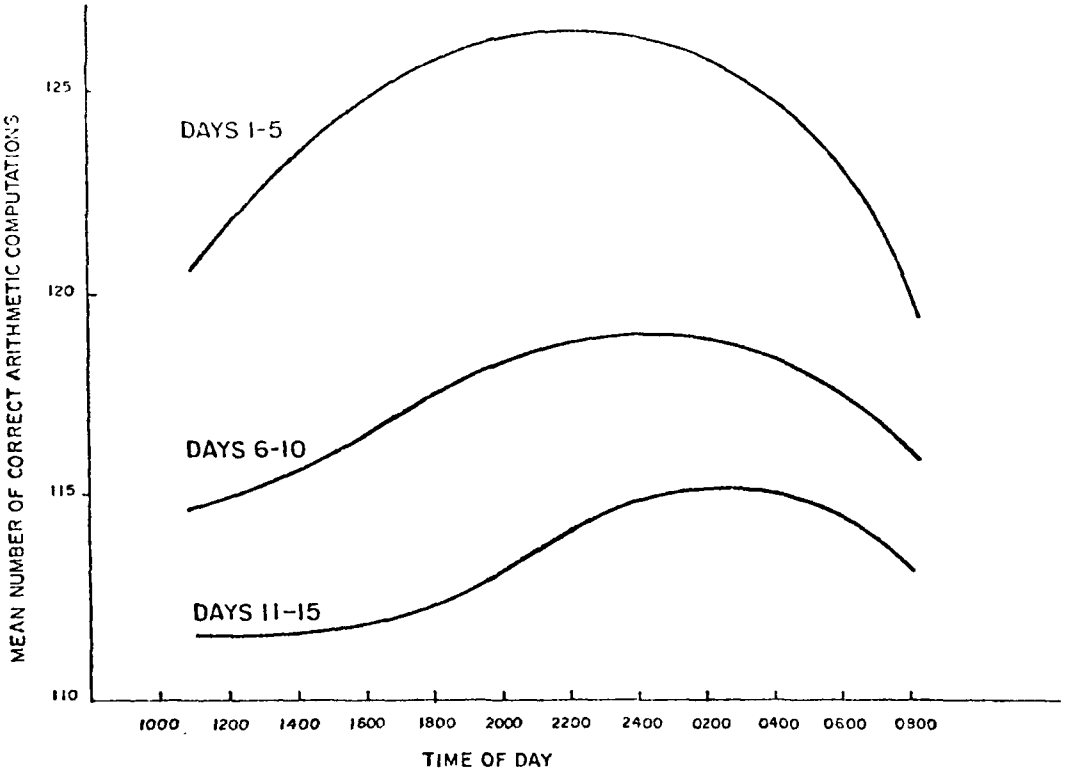
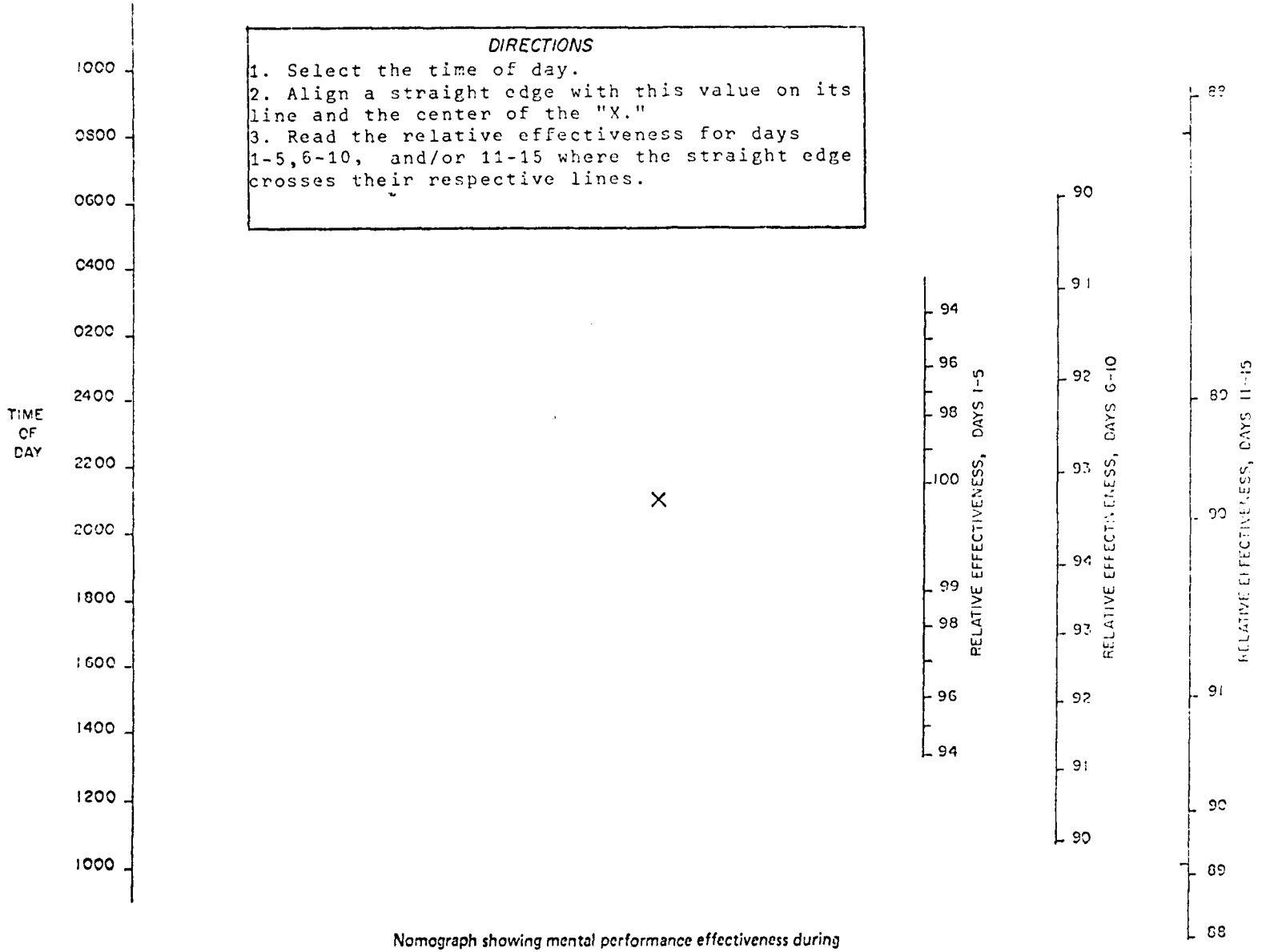


Figure 3.32. Average number of correct computations at different times of day during three 5-day periods of a 15-day period (4-2 work-rest schedule).

DIRECTIONS

1. Select the time of day.
2. Align a straight edge with this value on its line and the center of the "X."
3. Read the relative effectiveness for days 1-5, 6-10, and/or 11-15 where the straight edge crosses their respective lines.



Nomograph showing mental performance effectiveness during successive five day period.

CRITICAL TASK 62

Position: Platoon Leader

Task: Communicate With Company And/Or Artillery As Needed

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 63

Position: Platoon Leader

Task: Direct Vehicle Firing Locations

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Vision	Light Level/Visibility	9, 26, 44, 72
Hearing	Light Level/Visibility	22, 33
Orientation	Light Level/Visibility	7
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 64

Position: Platoon Leader

Task: Direct Vehicle Movement Patterns

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 65

Position: Platoon Leader

Task: Communicate With OPs and Company As Necessary

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 66

Position: Platoon Leader

Task: Decide When Or If To Relocate

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74

DISCUSSION

Deciding when or if to relocate represents higher mental process which could determine whether the platoon survives. In a study conducted by the British Army, soldiers were deprived of sleep and their reasoning ability was tested.

Interpretation

Figure 3.33 illustrates that the performance which is dependent on reasoning deteriorates with sleep loss. These results indicate that higher mental processes are adversely affected by partial and total sleep deprivation. All groups recovered after two days of rest.

To counteract the problem, training on comparable tasks to a high degree of overlearning should be undertaken. Decision aid development is also indicated. Full cross-checks of decisions based on complex reasoning should be instituted

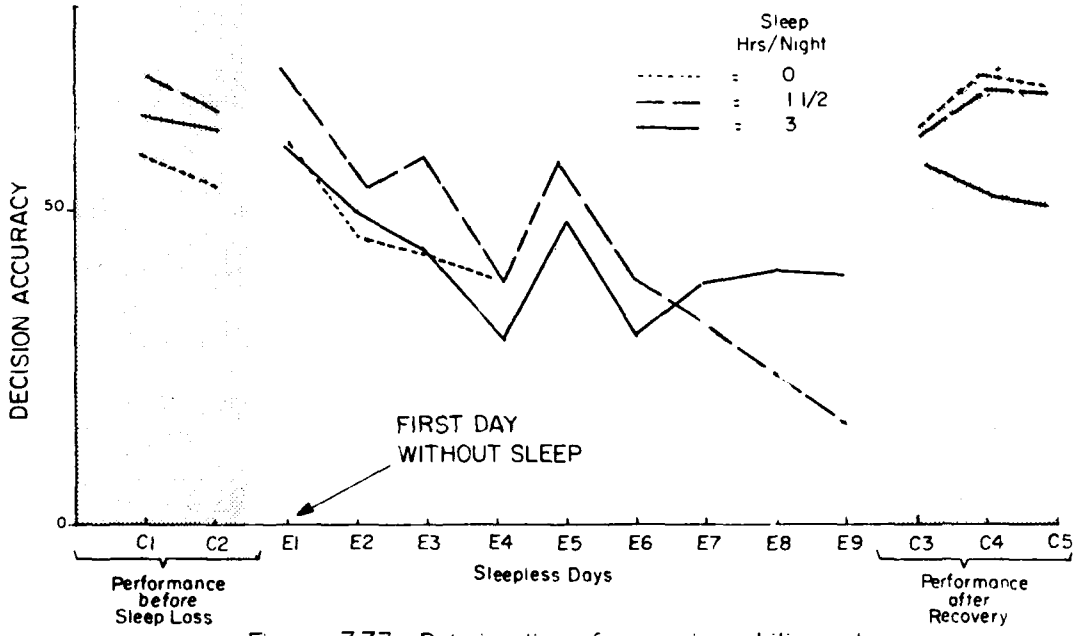


Figure 3.33. Deterioration of reasoning ability under varying conditions of sleep loss

CRITICAL TASK 67

Position: Platoon Leader

Task: Order Relocation

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 68

Position: Platoon Leader

Task: Direct Relocation Cover

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69
Communication	Stress	48

DISCUSSION

The ability to encode and decode is of obvious importance in a variety of combat tasks, and especially with respect to map or chart references. It is also a task that draws heavily on the critical abilities of Numerical Facility and Reasoning. While, both, encoding and decoding are affected by sleep-loss, the decrement seems to be more severe for encoding. This emerges as one result from a study of the effects of sleep loss on military performance.

The test of performance capability, which employed British soldiers as subjects, consisted of 25 six-digit map references (e.g., 567137) and 25 bigrams (e.g. BPAN) that had to be encoded and decoded, i.e., converted from one to the other, according to a complicated scheme. Codings and decodings alternated over a 10 minute time count.

Figure 3.34 presents the average (mean) number of correct encodings. For all three platoons under study, performance deteriorated with sleep loss. Cognitive functioning was adversely affected rather quickly for those totally deprived of sleep. All groups recovered after two days of rest.

Implications

To overcome the problem, the system could be redesigned to compensate for the types of errors most likely to occur. Alternatively, task rotation among cross-trained crew might also be employed to control errors. A change of activity often has a freshening affect on fatigued or sleep-deprived persons. Probably the best measure is to have the task performed independently by two or more people.

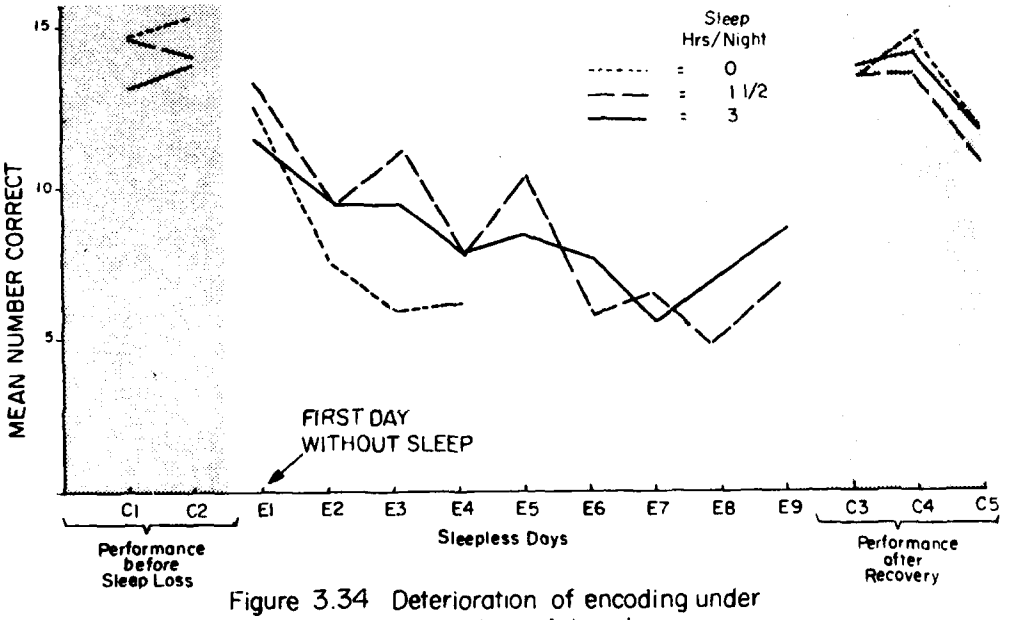


Figure 3.34 Deterioration of encoding under varying conditions of sleep loss

CRITICAL TASK 69

Position: Platoon Leader

Task: Coordinate Changes In TRPs After Relocation

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69
Communication	Stress	48

DISCUSSION

The constantly changing battlefield conditions during continuous operations differ from the usual because the inability to use nighttime periods to assess the status of the battle imposes on all personnel, especially those with command responsibility, the need to commit information to memory frequently. This constant process of memorization must take place during the battle in which the PL and the personnel must engage in a host of tasks. How much information must be memorized and how the interference of other tasks affects the memorization process is shown in Figure 3.35.

Interpretation

Figure 3.35 shows how devasting engaging in a concomitant task can be for memorization. Each curve shows how much of the originally presented information is remembered after various periods of time engaging in an irrelevant activity. The number of things to be remembered originally was different for each curve, ranging from one item for the upper curve to five items for the lower curve. Note that the more that has to be remembered, the greater the degrading effect of interfering tasks. The effect causes the ultimate amount of interference and the rate of interference to be greater.

Implications

The conclusions are that to the extent that the PL or other personnel must attempt to engage in other tasks while they are receiving information that they should commit to memory, their ability to memorize will be degraded; and, any information to be remembered should be memorized in a setting which does not require performance of interfering tasks.

The following points should be considered in connection with the memorization of information in the field:

(a) the information to be memorized should be kept to as small an amount as possible, preferably two or three items at a time

(b) the rehearsal of information presented for memorization should take place in a favorable environment that does not require attention to irrelevant tasks

(c) wherever and whenever possible, memory aids should be provided and organized information storage and retrieval systems should be provided.

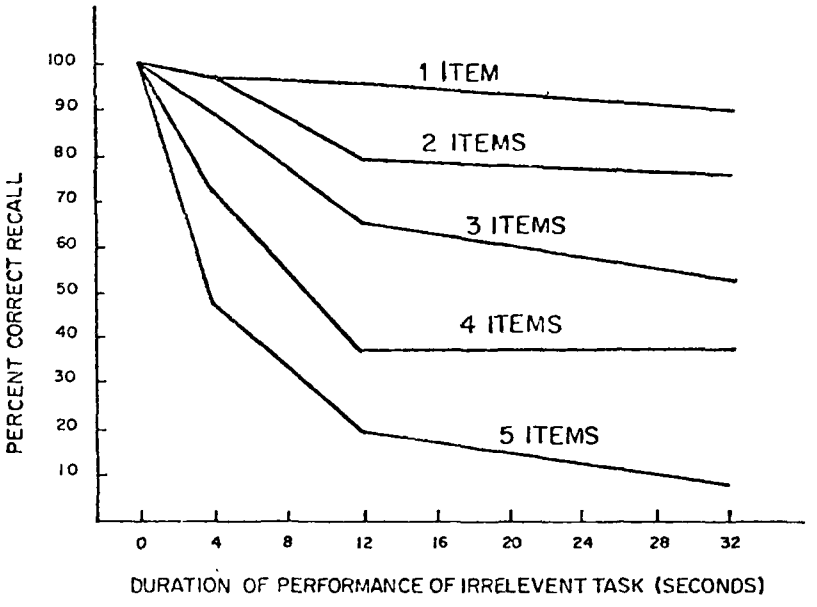
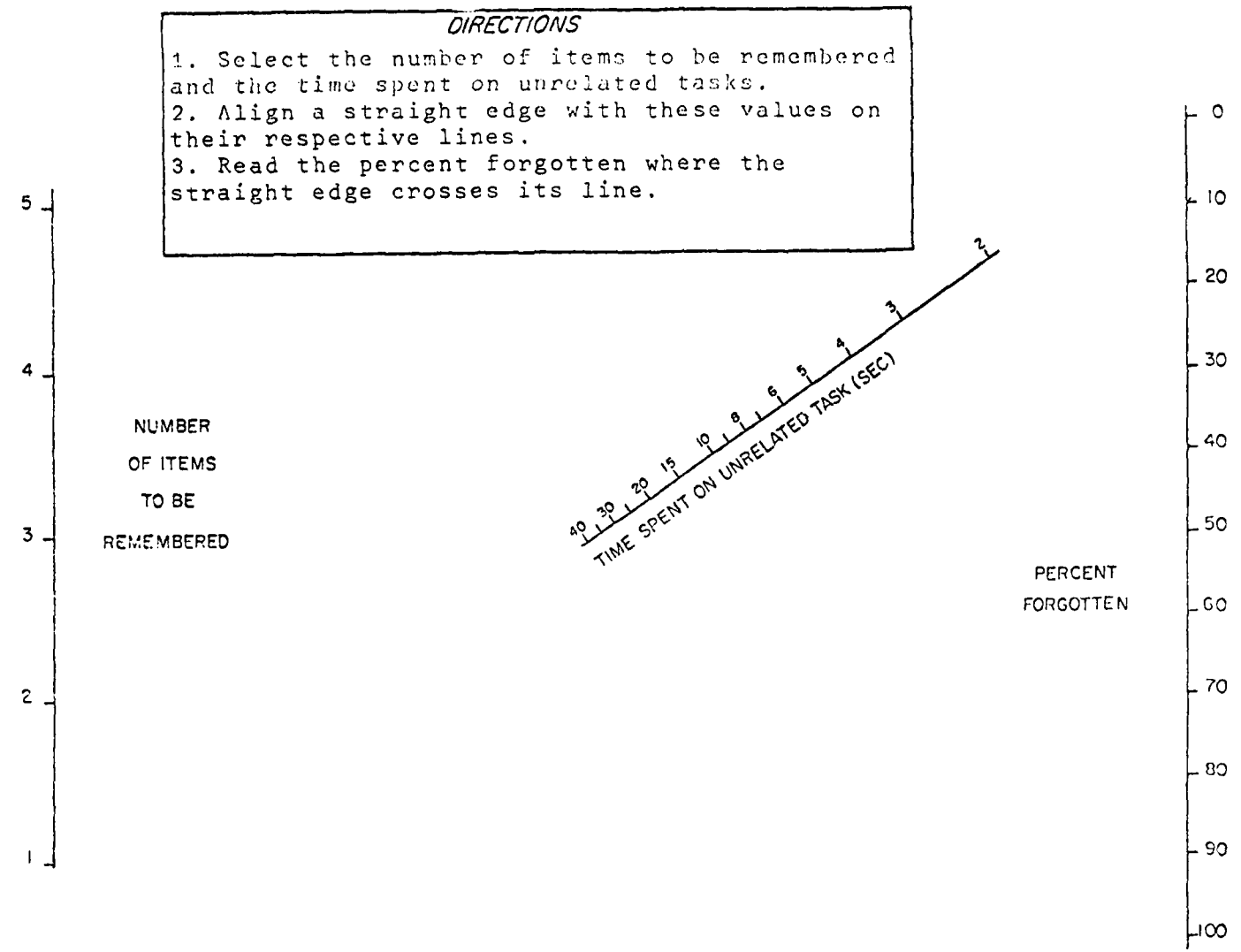


Figure 3.35. Memory for varying amounts of information when irrelevant tasks interfere with memorization.



Nomograph relating memory to time spent on unrelated task.

CRITICAL TASK 70

Position: Platoon Leader

Task: Order Move for Assembly Area

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 71

Position: Platoon Leader

Task: Direct Protective Fire for Move to Assembly

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
Hearing	Fatigue	19, 33
Orientation	Light Level/Visibility	7
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 72

Position: Platoon Leader

Task: Direct Squad Fire Zones While Mounted

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Numerical Facility	Diurnal Rhythm	11, 57, 61
Vision	Light Level/Visibility	9, 26, 44, 72
Hearing	Light Level/Visibility	22, 33
Memory	Stress	56, 69
Communication	Stress	48

DISCUSSION

The problem area concerns the effects of bright light flashes on visual performance. The problem is theoretically the same for the unaided eye as for the eye which is aided by a light intensification device. However, when using a night vision device, the problem becomes more serious. The effect of flashes of light on visual performance is called flash blindness. Flash blindness refers to the temporary decrese in visual ability which follows exposure to a short duration, high intensity light. At night, the flash from the enemy's or one's own fire may often be sufficient to cause flash blindness. Following a sufficiently intense flash, there will be a recovery period as shown in the following figure.

Interpretation

The highest flash energy shown in Figure 3.36 will cause permanent blindness. The only encountering of such a light is witnessing a nuclear detonation with unprotected eyes. The lowest flash in the graph corresponds roughly to a very minor flash, for example, a cigarette lighter being ignited. The curves show that the more intense the flash, the longer it takes to regain full visual acuity.

The curves also show that recovery time to see a dim target is longer than to see a light target. A bright target at daylight light levels (refer to the curve labelled 2.0 log mL/sec) would be no less visible after a flash until the flash is intense enough to cause eye damage or blindness.

The problem of night vision devices which amplify or intensify the light received at the eye must be evaluated in terms of each specific equipment. The manuals for each device should be consulted to see if the flash blindness dangers are spelled out. But, they will certainly be greater with night vision devices than with the unaided eyes.

Implications

Several steps can be taken to diminish the effect of flash blindness. The PL should keep these methods in mind:

1) The PL should minimize the amount of time spent looking toward enemy locations at night; obviously, if the PL reduces time spent looking toward the possible source of a flash, the less the probability of being exposed to a blinding flash.

2) The PL can immediately avert his gaze at the first hint of a flash; if the PL trains himself to do this, he can learn to avert his gaze in less than a quarter of a second. The light reflected by objects will be much less and will not cause flash blindness.

3) The PL should keep someone close at hand while he is using a night vision device who can immediately take over feeding vital visual information to the PL during any recovery period following flash blindness.

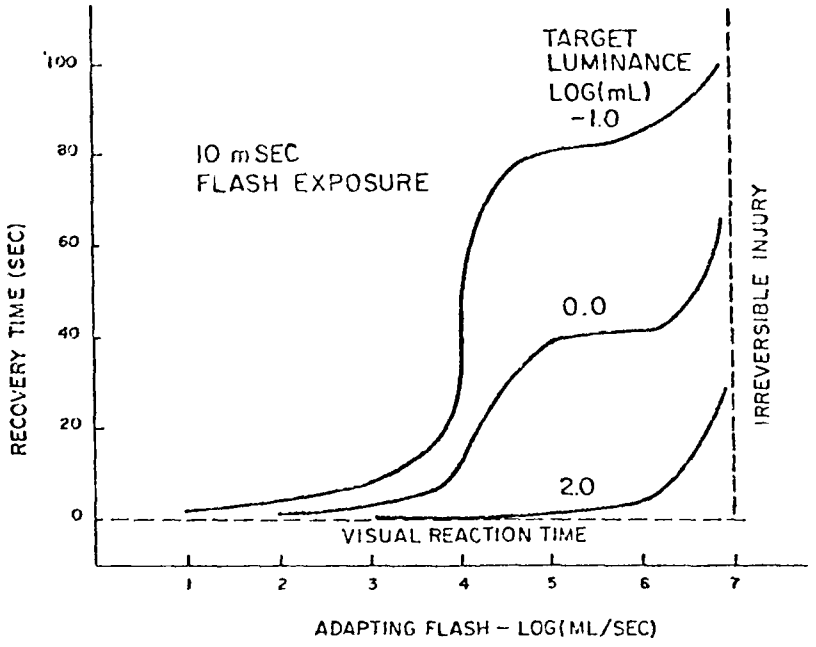


Figure 3.36. Relationship of flash energy to recovery time for targets of various brightness.

CRITICAL TASK 73

Position: Platoon Leader

Task: Direct Squad Fire Requirements While Mounted

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
Hearing	Fatigue	19, 33
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Memory	Stress	56, 69
Communication	Stress	48
Perceptual Speed	Fatigue	29, 30, 57

CRITICAL TASK 74

Position: Platoon Leader

Task: Direct Disengagement

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 30
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Hearing	Light Level/Visibility	22, 33
Communication	Stress	48

DISCUSSION

It is important for the leader of fighting soldiers to be able to think clearly while under the stress of battle. If he is sidetracked by irrelevancies, the result could be fatal. The results of a test of ability to resist distractions under various conditions of sleep loss are presented in the figure.

Interpretation

Distractability increases with sleep loss. It may be concluded that the more sleep deprived the soldier is, the more likely he is to be influenced by irrelevancies or nonpertinent information. All groups recovered after two days of rest.

Implications

To reduce impairment risks, the following procedures can be employed:

1. Training to a high degree of overlearning.

2. Persons responsible for complex decisions should be as isolated as possible from distracting influences.

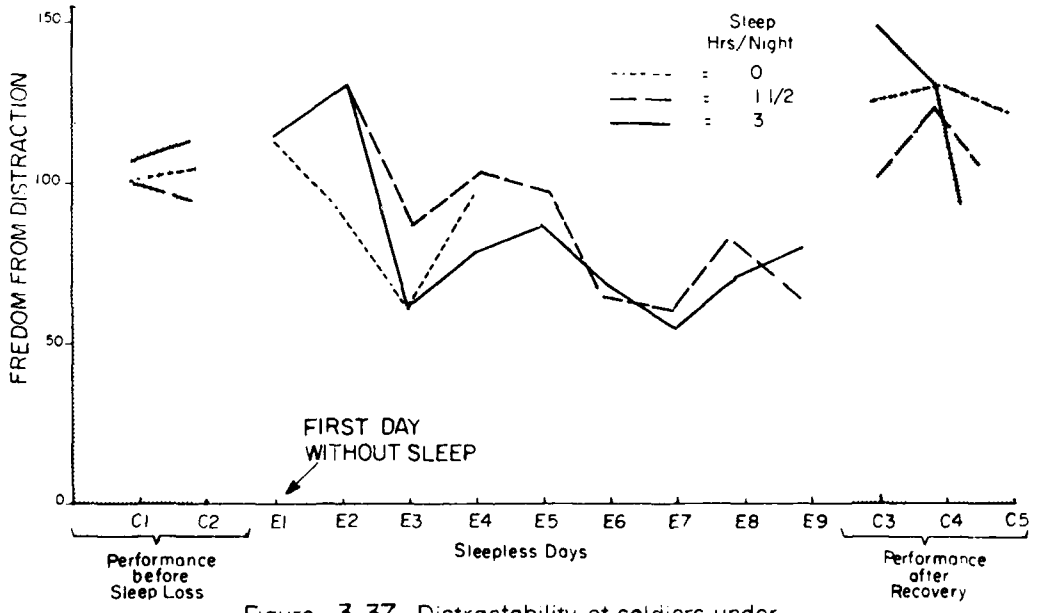


Figure 3.37 Distractability of soldiers under varying conditions of sleep loss

CRITICAL TASK 75

Position: Platoon Leader

Task: Call Indirect Fire Required for Disengagement

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 76

Position: Platoon Leader

Task: Coordinate Regrouping

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Communication	Stress	48

CHAPTER IV

TANK CREW PERFORMANCE

Projected performance degradation of armor units for duty positions, tank crews, and tank platoons are summarized. Detailed projections by tasks and defensive (platoon) actions are tabulated. Digests of adverse factors' impacts on 58 critical tasks are provided.

Summary of Consequences for Performance of Continuous Operations

As pointed out in the preceding chapter, of the four debilitating factors being considered fatigue (sleep-loss over 120 hours), light level or visibility conditions, stress and disruption of diurnal rhythms, fatigue will be the dominant factor. This will be true for any and all personnel regardless of the type of unit (infantry, armor, etc.) to which they belong and of the tasks they perform. It is also generally true that all tasks are not affected in the same way by the debilitating factors inherent in the conditions engendered by continuous operations.

To recapitulate: tasks having a preponderance of cognitive or vigilance components can be expected degrade most as the cumulative loss of sleep builds up. By contrast, simple motor tasks, that are highly practiced and routine, are unlikely to deteroriate significantly, at least, during the first two or three days; thereafter, deterioration may be slight to moderate depending on the degree of automaticity with which the person performs the given task.

As applied to tank crews, for example, loading a weapons magazine will show virtually no deterioration with sleep loss. Immediate actions, such as correcting a COAX MG malfunction, are likely to deteriorate somewhat. Even acutely sleep deprived Tank Gunners and Loaders are expected to perform their critical tasks with reasonable adequacy. On the other hand, the TK PL will progressively use less than optimal judgment on a task, such as, "selecting firing positions for the tanks." Since tank crew and platoon leadership involves a good deal of judgment and vigilance, the Tank Commanders (TK CDRs) and TK PLs may begin to deteriorate after the very first 24 hours of continuous operations.

A summary of the projected effectiveness of various positions of the Tank Crew over five days of continuous operations with little or no organized sleep appears as Figure 4.1. The position expected to degrade most rapidly is the PL whose tasks include a heavy cognitive component. Degraded least is

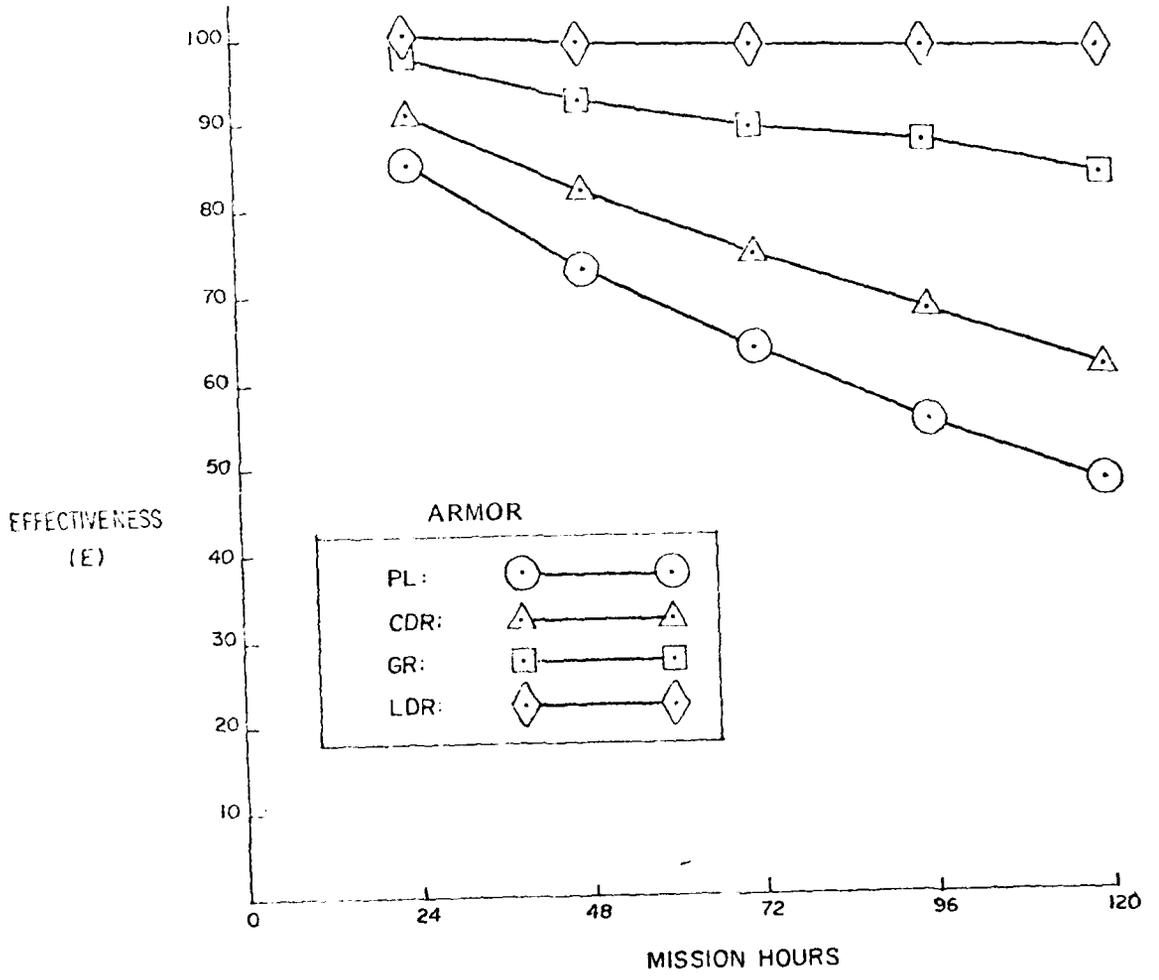


Figure 4.1. Performance degradation in armor duty positions. (PL = Tank Platoon Leader, CDR = Tank Commander. GR = Tank Gunner, LDC = Tank Leader)

the Tank Loader, who engages mostly in motor tasks that are often well-practiced or routine.

Figure 4.2 presents forecast performance effectiveness as a function of mission days for the Tank Crew and Platoon. The graphs illustrate that the Platoon degrades more rapidly than the crew.

Effectiveness of the TK PLT over mission days, contrasting best and worst conditions of impacting variables is presented as Figure 4.3. The graph illustrates that the influence of the debilitating factors (light level, stress and diurnal rhythms) is less than the influence of fatigue (sleep loss over five days) in degrading performance effectiveness.

This corresponds to uniform experience from informal observation as well as scientific studies. Also, fatigue levels correspond to a progression over 120 hours, while the other debilitating factors are viewed as either present (acting) or absent (not acting).

While a TK PLT normally consists of five tanks, a considerably degraded condition of only three tanks was assumed for calculation of the effectiveness values shown in Tables 4.1 and 4.2. Since the scenario (Chapter II) assumed 6 to 1 odds, this suggested itself as a realistic expectation about TK PLT operations. Similarly, the tank crew was assumed to consist of three, rather than the usual four persons: a TK CDR, a Gunner and a Loader. The six day Arab-Israeli war demonstrated that, with some loss in mobility, even two man tanks are effective weapons if the crew is cross-trained.

Table 4.1 presents the projected effectiveness of Tank Positions/Crew, and Platoon for different platoon actions and mission days (sleep/loss). The projected values indicate that wide variation in performance can be expected for different positions and platoon actions. Best and worst performance can range between very effective, e.g., 100 and grossly ineffective, e.g., 28, under different conditions.

Table 4.2 presents the effectiveness of Tank Positions, Crew, and Platoon as a function of adverse impacting factors over five days of continuous operations.

Debilitating factors are coded as follows:

F = Fatigue level in mission hours (24-120);
L = Light level: 1 dark and 0 light;
S = Stress: 1 = stress present and O = Stress absent
D = Diurnal Rhythm: 1 = rhythm out of phase and O = rhythm in phase.

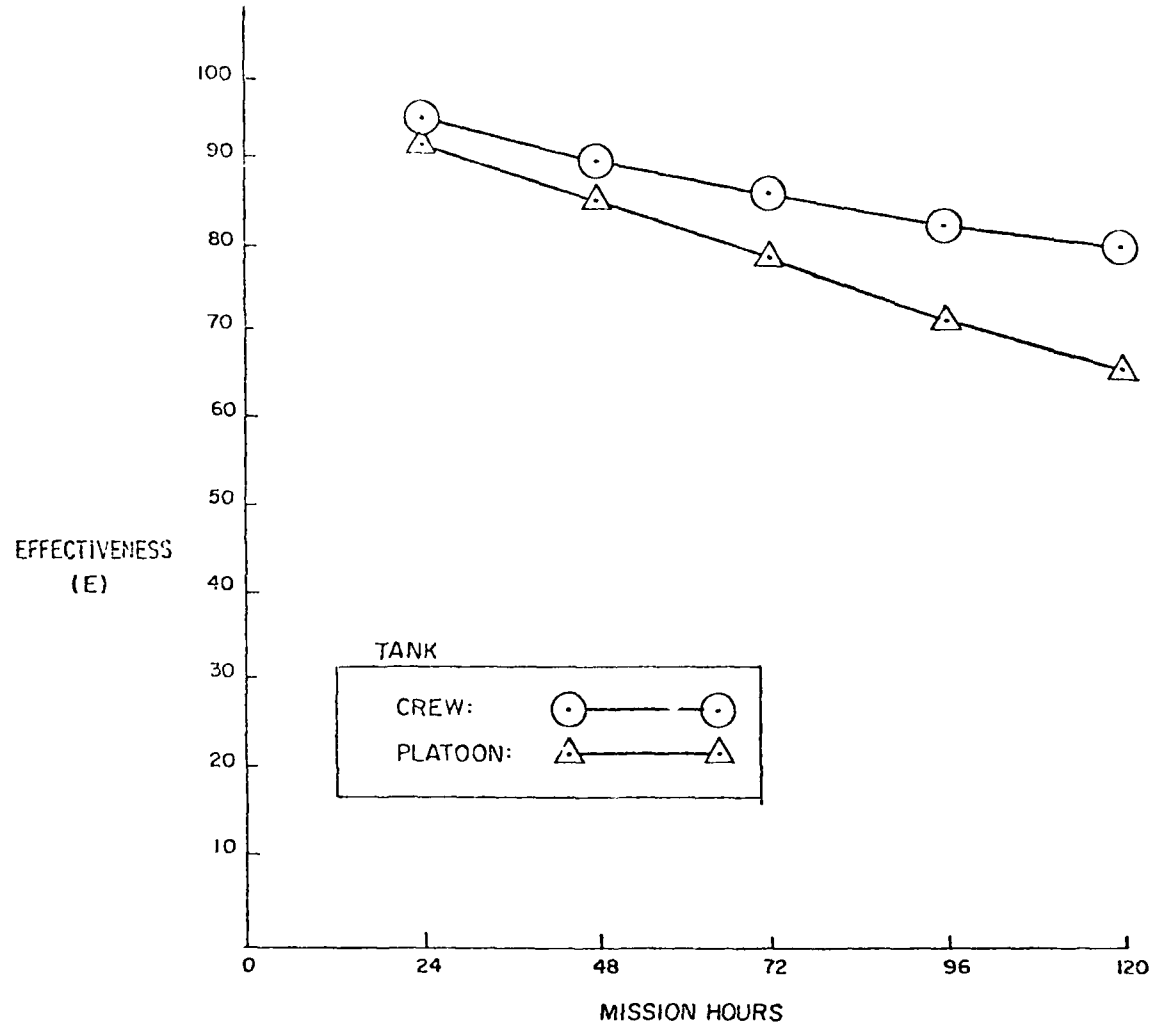


Figure 4.2. Performance degradation in tank crews and platoons with all adverse factors present.

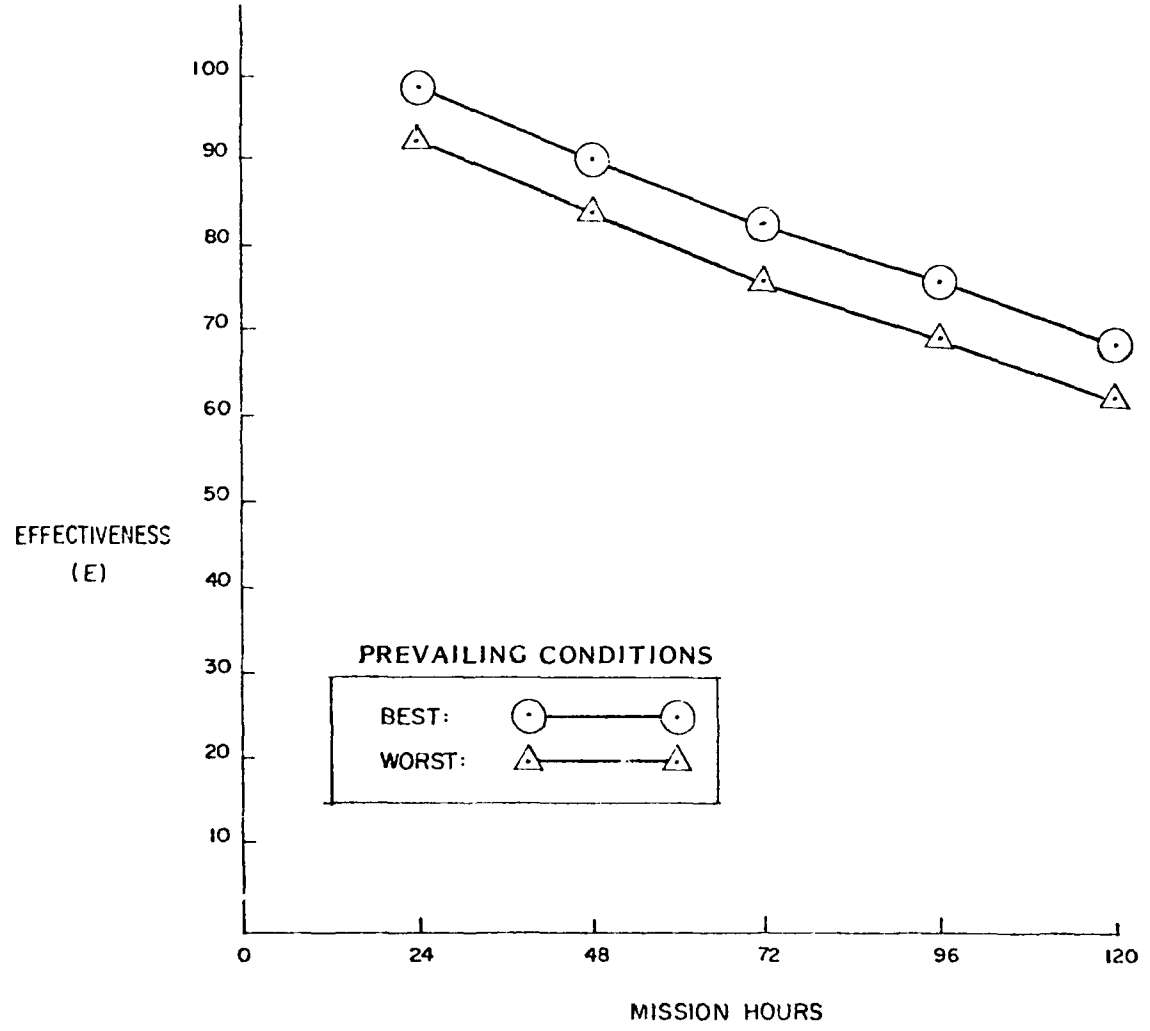


Figure 4.3. Projected performance degradation of tank crews and platoons under best and worst conditions.

Table 4.1

Effectiveness (E) of Armor: Tank Duty Positions, Crews and Platoons in Different Platoon Actions and Over Mission Days

		Duty Position				Tank	
	Day	PL	CDR	LDR	GR	Crew	Platoon
Platoon	1	77	81	99	100	93	87
Action	3	46	54	96	100	80	65
1	5	28	36	93	100	70	50
Platoon	1	94	97	100	100	99	97
Action	3	84	92	100	100	97	91
2	5	75	87	100	100	95	86
Platoon	1	87	95	100	90	95	92
Action	3	67	85	100	74	86	80
3	5	51	76	100	59	77	68
Platoon	1	86	91	99	97	95	92
Action	3	64	75	99	90	87	78
1,2,3	5	47	62	98	84	80	66

Table 4.2

Effectiveness (E) of Armor: Tank Duty Positions, Crews and Platoons Under All Combinations of Adverse Conditions

Impacting Debilitating Factors				Duty Position				Tank	
F	L	S	D	PL	CDR	LDR	GR	Crew	Platoon
24	0	0	0	95	97	99	99	98	97
24	0	0	1	92	96	99	99	98	96
24	0	1	0	91	94	99	98	97	95
24	1	0	0	92	94	99	98	97	95
24	0	1	1	88	94	99	98	97	93
24	1	0	1	90	93	99	98	96	94
24	1	1	0	89	92	99	97	96	94
24	1	1	1	86	91	99	97	95	92
48	0	0	0	81	88	99	95	93	89
48	0	0	1	79	88	99	95	93	88
48	0	1	0	78	86	99	94	92	87
48	1	0	0	80	86	99	94	92	88
48	0	1	1	76	85	99	94	92	86
48	1	0	1	77	85	99	94	92	87
48	1	1	0	76	83	99	93	91	86
48	1	1	1	74	83	99	93	91	85
72	0	0	0	70	80	99	92	90	82
72	0	0	1	68	80	99	92	90	81
72	0	1	0	67	78	99	91	89	80
72	1	0	0	69	78	99	91	89	81
72	0	1	1	66	77	99	91	88	80
72	1	0	1	67	77	99	91	88	80
72	1	1	0	66	75	99	90	87	79
72	1	1	1	64	75	99	90	87	78
96	0	0	0	61	72	98	89	85	76
96	0	0	1	59	72	98	89	85	75
96	0	1	0	58	71	98	88	85	74
96	1	0	0	59	70	98	88	84	75
96	0	1	1	56	70	98	88	84	73
96	1	0	1	58	70	98	88	84	74
96	1	1	0	57	68	98	87	83	73
96	1	1	1	55	68	98	87	83	72
120	0	0	0	52	66	98	86	82	70
120	0	0	1	51	65	98	86	81	69
120	0	1	0	50	64	98	85	81	68
120	1	0	0	51	64	98	85	81	69
120	0	1	1	48	64	98	85	81	67
120	1	0	1	49	64	98	85	81	68
120	1	1	0	48	62	98	84	80	67
120	1	1	1	47	62	98	84	80	66

Here, too, the tabled values indicate that fatigue (sleep loss over mission days) is more important in degrading performance over five days than any of the other factors.

Here, again, it should be noted that values of E (the effectiveness index) in Table 4.2 represent all possible degrees or combinations in the impact of the debilitating factors on performance. The least degradation occurs with the 24, 0, 0, 0 combination of debilitating factors, and the greatest degradation with the 120, 1, 1, 1 combination. Intermediate conditions lie between these extremes. The E values shown on Table 4.2 represent the indicated hour, i.e., the last hour of the first, second, third, fourth and fifth days of continuous combat operations.

Table 4.3 presents the projected effectiveness (E) for critical combat tasks performed by the several duty positions of Armor (Tank Platoon). Successive parts of Table 4.3 present projected values of E for tasks performed by the Tank Platoon Leader (TK PL), Tank Commander (TK CDR), Tank Gunner (TK GR) and Tank Loader (TK LDR). Values of E are tabled for each of the three types of defensive platoon actions (1, 2, and 3) and for the average across the three types (Platoon Actions 1, 2, 3). In each case values are given for the (last hour of) first, second, third, fourth and fifth day of continuous combat operations.

Here, as for Mechanized Infantry, the pattern of projected values is most characterized by variability of effectiveness across tasks and platoon actions. Again, some tasks degrade only nominally over five days (120 hours) of continuous operations, while others, become very quickly degraded to unacceptable levels. Examples of tasks degraded only nominally are Task No. 48 (loading machine guns) and Task No. 54 (operating the breech mechanism). Both of these tasks are normally performed by the TK LDR. On the other hand, Task No. 3 (selecting firing position for tanks), Task No. 4 (selecting observation posts), Task No. 5 (selecting routes), and Task No. 6 (selecting alternate positions) are all examples of tasks that are projected to degrade very substantially. All are tasks normally performed by the TK PL.

Table 4.4 presents a descriptive summary of the impacts of debilitating factors on the critical abilities of the personnel of TK PL relevant to the performance of their critical tasks. The table heading shows the abilities (see taxonomy in Chapter I) needed for task performance and the debilitating factors (see Chapter I) impacting on these abilities. Only the impacts are recorded in the body of the table. That means that the absence of an entry may be due to the fact that: (a) the task in question is not critical on the given platoon action, (b) the ability in question is not critical for the given task, or (c) the ability in question is not depressed in this task and platoon action. Where there is an entry in the table a "1"

Table 4.3

Projected Effectiveness (E) for Critical Combat Tasks: Armor
Tank Platoon Leader

		Task No.																
	Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Platoon Action$_1$	1	100	100	71	65	71	71	71	92	100	100	100	71	71	56	67	66	78
	2	100	100	51	43	51	51	51	84	100	100	100	51	51	31	45	44	61
	3	100	100	36	28	36	36	36	78	100	100	100	36	36	17	30	29	46
	4	100	100	26	18	26	26	26	71	100	100	100	26	26	10	20	19	37
	5	100	100	18	12	18	18	18	65	100	100	100	18	18	05	13	13	29
Platoon Action$_2$	1	100	100	84	100	100	84	100	100	100	92	100	100	100	56	92	100	84
	2	100	100	71	100	100	71	100	100	100	84	100	100	100	31	84	100	71
	3	100	100	59	100	100	59	100	100	100	78	100	100	100	17	78	100	59
	4	100	100	50	100	100	50	100	100	100	71	100	100	100	10	71	100	50
	5	100	100	42	100	100	42	100	100	100	65	100	100	100	05	65	100	42
Platoon Action$_3$	1	78	73	78	78	78	78	78	100	100	100	100	100	100	100	100	100	100
	2	61	53	61	61	61	61	61	100	100	100	100	100	100	100	100	100	100
	3	48	38	48	48	48	48	48	100	100	100	100	100	100	100	100	100	100
	4	37	28	37	37	37	37	37	100	100	100	100	100	100	100	100	100	100
	5	29	20	29	29	29	29	29	100	100	100	100	100	100	100	100	100	100
Platoon Actions 1, 2, 3	1	92	90	78	80	82	78	82	97	100	97	100	89	89	68	85	87	87
	2	85	81	60	64	68	60	68	95	100	95	100	80	80	46	72	76	76
	3	78	73	47	51	56	47	56	92	100	92	100	71	71	31	61	66	66
	4	72	65	36	41	46	36	46	89	100	89	100	64	64	21	52	57	57
	5	66	59	28	33	38	28	38	87	100	87	100	57	57	14	44	50	50

Table 4.3 (Cont.)

Tank Loader

Task No.

	Day	47	48	49	50	51	52	53	54	55	56	57	58
Platoon Action$_1$	1	100	100	100	100	100	100	100	100	100	92	92	100
	2	100	100	100	100	100	100	100	100	100	84	84	100
	3	100	100	100	100	100	100	100	100	100	78	78	100
	4	100	100	100	100	100	100	100	100	100	71	71	100
	5	100	100	100	100	100	100	100	100	100	65	65	100
Platoon Action$_2$	1	100	100	100	100	100	100	100	100	100	100	100	100
	2	100	100	100	100	100	100	100	100	100	100	100	100
	3	100	100	100	100	100	100	100	100	100	100	100	100
	4	100	100	100	100	100	100	100	100	100	100	100	100
	5	100	100	100	100	100	100	100	100	100	100	100	100
Platoon Action$_3$	1	100	100	100	100	100	100	100	100	100	100	100	100
	2	100	100	100	100	100	100	100	100	100	100	100	100
	3	100	100	100	100	100	100	100	100	100	100	100	100
	4	100	100	100	100	100	100	100	100	100	100	100	100
	5	100	100	100	100	100	100	100	100	100	100	100	100
Platoon Actions 1, 2, 3	1	100	100	100	100	100	100	100	100	100	97	97	100
	2	100	100	100	100	100	100	100	100	100	95	95	100
	3	100	100	100	100	100	100	100	100	100	92	92	100
	4	100	100	100	100	100	100	100	100	100	89	89	100
	5	100	100	100	100	100	100	100	100	100	87	87	100

Table 4.3 (Cont.)

Tank Platoon Leader (Cont.)

		Task No.								
	Day	18	19	20	21	22	23	24	25	26
Platoon Action$_1$	1	61	92	100	84	66	84	51	71	85
	2	37	84	100	71	44	71	27	51	73
	3	23	78	100	59	29	59	14	36	62
	4	14	71	100	50	19	50	07	26	53
	5	08	65	100	42	13	42	04	18	45
Platoon Action$_2$	1	92	100	100	100	100	100	84	100	100
	2	84	100	100	100	100	100	71	100	100
	3	78	100	100	100	100	100	59	100	100
	4	71	100	100	100	100	100	50	100	100
	5	65	100	100	100	100	100	42	100	100
Platoon Action$_3$	1	100	100	100	100	66	73	51	71	100
	2	100	100	100	100	44	53	27	51	100
	3	100	100	100	100	29	38	14	36	100
	4	100	100	100	100	19	28	07	26	100
	5	100	100	100	100	13	20	04	18	100
Platoon Actions 1, 2, 3	1	82	97	100	94	76	85	61	80	95
	2	68	95	100	89	58	72	37	64	90
	3	56	92	100	84	44	61	22	51	85
	4	46	89	100	79	33	52	14	41	81
	5	38	87	100	75	25	44	08	32	77

Table 4.3 (Cont.)

Tank Gunner

		Task No.				
	Day	42	43	44	45	46
Platoon Action$_1$	1	100	100	100	100	100
	2	100	100	100	100	100
	3	100	100	100	100	100
	4	100	100	100	100	100
	5	100	100	100	100	100
Platoon Action$_2$	1	100	100	100	100	100
	2	100	100	100	100	100
	3	100	100	100	100	100
	4	100	100	100	100	100
	5	100	100	100	100	100
Platoon Action$_3$	1	84	84	100	100	84
	2	71	71	100	100	71
	3	59	59	100	100	59
	4	50	50	100	100	50
	5	42	42	100	100	42
Platoon Actions 1, 2, 3	1	94	94	100	100	94
	2	89	89	100	100	89
	3	84	84	100	100	84
	4	79	79	100	100	79
	5	75	75	100	100	75

Table 4.3.(Cont.)

Tank Commander

	Day	Task No. 27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
Platoon Action$_1$	1	92	92	84	77	100	78	72	85	56	92	92	84	66	73	92
	2	84	84	71	59	100	61	52	73	32	84	84	71	44	53	84
	3	78	78	59	45	100	48	37	62	18	78	78	59	29	38	78
	4	71	71	50	35	100	37	27	53	10	71	71	50	19	28	71
	5	65	65	42	27	100	29	19	45	06	65	65	42	13	20	65
Platoon Action$_2$	1	100	100	92	100	100	84	100	100	84	100	100	100	100	100	100
	2	100	100	84	100	100	71	100	100	71	100	100	100	100	100	100
	3	100	100	78	100	100	59	100	100	59	100	100	100	100	100	100
	4	100	100	71	100	100	50	100	100	50	100	100	100	100	100	100
	5	100	100	65	100	100	42	100	100	42	100	100	100	100	100	100
Platoon Action$_3$	1	100	92	100	100	100	100	100	100	100	100	100	100	66	73	100
	2	100	84	100	100	100	100	100	100	100	100	100	100	44	53	100
	3	100	78	100	100	100	100	100	100	100	100	100	100	29	38	100
	4	100	71	100	100	100	100	100	100	100	100	100	100	19	28	100
	5	100	65	100	100	100	100	100	100	100	100	100	100	13	20	100
Platoon Actions 1, 2, 3	1	97	94	92	92	100	87	90	95	78	97	97	94	76	81	97
	2	95	89	84	84	100	76	80	90	61	95	95	89	58	65	95
	3	92	84	77	77	100	66	72	85	47	92	92	84	44	53	92
	4	89	80	71	70	100	57	64	81	37	89	89	79	33	43	89
	5	87	75	65	64	100	50	58	77	29	87	87	75	25	35	87

denotes a significant (greater than 20%) depression of the ability in Platoon Action 1, a "2" denotes the same for Platoon Action 2, and a "3" represents Platoon Action 3.

As well as a descriptive summary of adversely affected critical abilities in critical tasks, Table 4.4 serves as a cross index. The following information can be obtained from the cross-index:

a. Critical tasks performed by various duty positions

b. Source(s) of adverse impacts on critical abilities

c. Adversely affected (depressed) critical abilities in critical tasks

d. Adversely affected tasks in platoon actions

e. Combinations of the above

As before, the cross-index can be used to answer various questions, such as:

- Who performs a given task?
- Which critical abilities are depressed in which task and which platoon action?
- Which conditions (debilitating factors) determine decrements in which critical ability(ies)?
- Which tasks experience parallel patterns of degradation?

Underlying Table 4.4 is the premise that a set of relations governs the depressive effect of the debilitating factors on the various critical abilities. Only some debilitating factors affect some abilities. The relation between debilitating factors and the critical abilities on which they act was summarized in Table 3.5 (in the preceding chapter).

Digest of Critical Tasks and Their Performance

Succeeding portions of this chapter present a detailed description of what is known about how the conditions associated with continuous operations affect the performance of each of the 58 critical tasks of the TK PLT. The derivation of task criticality is fully described in a companion report, Background Data, Vol. III Human Performance in Continuous Operations Guidelines. Here, the performance of each task is reviewed in terms of its behavioral requirements. For example, the TK PL Task No. 4, "selecting observation posts," requires the critical abilities Reasoning and Orientation, which are affected by Fatigue, Diurnal Rhythms, Stress, and Darkness.

Table 4.4

Armor: Summary of Significant Depressions of Critical Abilities

	TASK NO.	FATIGUE						DIURNAL RHYTHM		LIGHT LEVEL				STRESS			
		V	H	NF	R	PS	O	NF	R	V	H	DP	O	M	R	PS	S
PLATOON LEADER	1								3				3		3		3
	2								3				3		3		3
	3				123		1 3		12						1 3		
	4				1		1		1				1		1		
	5				1 3		1 3		1						1 3		
	6				123		1 3		12						1 3		
	7				123		1 3		12						1 3		
	8																1
	9																
	10													2			
	11																
	12				1		1		1						1		
	13				1		1		1						1		
	14			2	12		1	12	12				12	12	12		
	15	1				1				1			12			1	
	16				1	1			1	1					1		
	17				12				12								1
	18				1		1			12					1		1
	19									1							
	20																
	21	1								1							
	22				1 3	1 3			1	1 3					1 3		
	23					3	1 3						1 3				3
	24			1 3		1 3	123	1 3		1 3			123			1 3	1 3
	25				1 3				1 3						1 3		1 3
	26													1			1
TANK COMMANDER	27																1
	28																1 3
	29						1 3						12				
	30				1				1						1		
	31																
	32				12								12				1
	33	1	1							1	1						
	34									1				1			
	35	1				1	12			1			12			1	1
	36									1							
	37																
	38	1								1							
	39				1 3	1 3			1 3	1 3					1 3		
	40	1 3				1 3				1 3							1 3
	41																1
GUNNER	42	3				3				3							3
	43	3				3				3							3
	44																
	45																
	46	3								3							
LOADER	47																
	48																
	49																
	50																
	51																
	52																
	53																
	54																
	55																
	56																
	57														1		
	58																

The relationships between a critical ability and one of the unique stressors of continuous operations are presented in the previous chapter on the Mechanized Infantry.

Each task shows on index which lists the critical performance abilities required. Unless otherwise noted, the degradation effects for the tasks listed in this chapter are the same as for the tasks for which involved critical abilities are discussed in the previous chapter (Chapter III). The interpretations and implications are also the same. Table 4.5 identifies where a discussion appears on how debilitating factors degrade the abilities of the personnel of TK PLTs to perform their tasks. This table is also relevant to FIST, Artillery and Mechanized Infantry personnel where tasks demand common abilities.

The task digests which follow provide a compendium of information pertaining to each of the identified critical tasks. Each digest provides the basic identifying information: Task No., Duty Position which normally carries out this task, and the Task Title. Then the defensive (platoon) action in which this task is highly critical is indicated. Next, the critical abilities required for task performance are listed together with the adverse debilitating factors impacting on and depressing the abilities. Also, listed are Task Nos. under which the impacts of debilitating factors on abilities are discussed. Note that these Task Nos. refer to the tasks of the Mechanized Infantry (see Chapter III).

Table 4.5

Armor: Index of Discussions of Effects of Debilitating Factors on Critical Abilities

Debilitating Factor	Critical Ability	Discussed Under Mechanized Infantry Task No. (Ch. III)
Fatigue	Vision	1, 30, 33
	Hearing	19, 33
	Numerical Facility	57, 66, 68
	Reasoning	57, 66, 68, 74
	Perceptual Speed	29, 30, 57
	Orientation	7, 29, 33
Diurnal Rhythm	Numerical Facility	11, 57, 61
	Reasoning	11, 57, 61
Light Level	Vision	9, 26, 44, 72
	Hearing	22, 33
	Dynamic Precision	18, 20
	Orientation	7
Stress	Memory	56, 69
	Reasoning	45, 53, 54, 74
	Perceptual Speed	2, 6
	Communication	48

NOTES: 1. Task Nos. in body of table refer to task digests appearing in Chapter III.

2. Discussion in task digests are relevant to Armor, Artillery and FIST where common abilities are required.

CRITICAL TASK 1

Position: Tank Platoon Leader

Task: Coordinate with 81mm FO (Fire Planning)

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 2

Position: Tank Platoon Leader

Task: Coordinate with Artillery FO (Fire Planning)

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 3

Position: Tank Platoon Leader

Task: Select Firing Position for Tanks

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33

CRITICAL TASK 4

Position: Tank Platoon Leader

Task: Select Observation Posts

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 5

Position: Tank Platoon Leader

Task: Select Routes

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33

CRITICAL TASK 6

Position: Tank Platoon Leader

Task: Select Alternate Positions

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33

CRITICAL TASK 7

Position: Tank Platoon Leader

Task: Select Supplementary Positions

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33

CRITICAL TASK 8

Position: Tank Platoon Leader

Task: Communicate Positioning of Tanks to the Tank CDRS

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 9

Position: Tank Platoon Leader

Task: Operate Intercom/Radio

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	None	
Communication	None	

CRITICAL TASK 10

Position: Tank Platoon Leader

Task: Supervise Defensive Preparations

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	Stress	56, 69

CRITICAL TASK 11

Position: Tank Platoon Leader

Task: Inspect for Readiness

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	None	
Perceptual Speed	None	
Reasoning	None	

CRITICAL TASK 12

Position: Tank Platoon Leader

Task: Approve Tank Commander's Firing Data

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	*Adverse Factor(s)*	*Discussed with Task No.*
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33

CRITICAL TASK 13

Position: Tank Platoon Leader

Task: Approve FOs Fire Plan

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33

CRITICAL TASK 14

Position: Tank Platoon Leader

Task: Prepare PLT Fire Plan

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69

CRITICAL TASK 15

Position: Tank Platoon Leader

Task: Acquire Targets

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Light Level/Visibility	7

CRITICAL TASK 16

Position: Tank Platoon Leader

Task: Determine When To Commence Engagement

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 17

Position: Tank Platoon Leader

Task: Order FOs To Adjust Fires

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 57, 61
	Diurnal Rhythm	11, 57, 61
Communication	Stress	48

CRITICAL TASK 18

Position: Tank Platoon Leader

Task: Control Employment Of Coordinated PLT Tank Fires

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
Vision	Light Level/Visibility	9, 26, 44, 72
Communication	Stress	48

CRITICAL TASK 19

Position: Tank Platoon Leader

Task: Operate Laser Range Finder

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 20

Position: Tank Platoon Leader

Task: Override Gunner's Traverse

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Perceptual Speed	None	
Reasoning	None	

CRITICAL TASK 21

Position: Tank Platoon Leader

Task: Fire .50 Cal MG

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 22

Position: Tank Platoon Leader

Task: Decide When (if) to Relocate

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 23

Position: Tank Platoon Leader

Task: Control Formations On The Move

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Perceptual Speed	Fatigue	29, 30, 57
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 24

Position: Tank Platoon Leader

Task: Adjust Indirect Fires

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Communication	Stress	48

CRITICAL TASK 25

Position: Tank Platoon Leader

Task: Issue Fragmentary Orders

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 26

Position: Tank Platoon Leader

Task: Issue Spot Reports

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 27

Position: Tank Commander

Task: Coordinate With Gunner

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 28

Position: Tank Commander

Task: Coordinate With Driver

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 29

Position: Tank Commander

Task: Occupy Firing Position

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 30

Position: Tank Commander

Task: Plan Fire Control Measures

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74

CRITICAL TASK 31

Position: Tank Commander

Task: Escort PL or TM CDR During Inspection

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	None	
Hearing	None	
Memory	None	

CRITICAL TASK 32

Position: Tank Commander

Task: Report Enemy Sightings

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 33

Position: Tank Commander

Task: Acquire Targets

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Hearing	Fatigue	19, 33
	Light Level/Visibility	22, 33

CRITICAL TASK 34

Position: Tank Commander

Task: Engage Targets on Order

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69

CRITICAL TASK 35

Position: Tank Commander

Task: Adjust Indirect Fires

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 32
	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
	Light Level Visibility	7
Communication	Stress	48

CRITICAL TASK 36

Position: Tank Commander

Task: Operate Laser Range Finder

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 37

Position: Tank Commander

Task: Issue Crew Fire Commands

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 38

Position: Tank Commander

Task: Fire .50 Cal MG

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 39

Position: Tank Commander

Task: Decide When (or if) to Relocate

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Perceptual Speed	Fatigue	29, 30, 57
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 40

Position: Tank Commander

Task: Control Driver Actions When Moving

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Fatigue	29, 30, 57
Communication	Stress	48

CRITICAL TASK 41

Position: Tank Commander

Task: Transmit Spot Reports to Tank Platoon Leader

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 42

Position: Tank Gunner

Task: Acquire Targets

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Fatigue	29, 30, 57
Communication	Stress	48

CRITICAL TASK 43

Position: Tank Gunner

Task: Track Targets

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Fatigue	29, 30, 57
Communication	Stress	48

CRITICAL TASK 44

Position: Tank Gunner

Task: Receive Fire Commands from TK CDR

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	None	
Hearing	None	

CRITICAL TASK 45

Position: Tank Gunner

Task: Fire Main Gun

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Perceptual Speed	None	

CRITICAL TASK 46

Position: Tank Gunner

Task: Fire COAX MG

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 47

Position: Tank Loader

Task: Load COAX MG

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Dynamic Precision	None	

CRITICAL TASK 48

Position: Tank Loader

Task: Load 50 CAL MG

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Dynamic Precision	None	

CRITICAL TASK 49

Position: Tank Loader

Task: Handle Main Gun Rounds

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Dynamic Precision	None	
Memory	None	

CRITICAL TASK 50

Position: Tank Loader

Task: Load Selected Rounds

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Dynamic Precision	None	
Memory	None	

CRITICAL TASK 51

Position: Tank Loader

Task: Conduct WPN Safety Checks

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Perceptual Speed	None	
Memory	None	

CRITICAL TASK 52

Position: Tank Loader

Task: Conduct Communication Operation Checks

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	None	
Communication	None	
Memory	None	

CRITICAL TASK 53

Position: Tank Loader

Task: Set Head Space and Timing on .50 Cal MG

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Dynamic Precision	None	
Vision	None	

CRITICAL TASK 54

Position: Tank Loader

Task: Operate Breech Mechanism

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Dynamic Precision	None	
Perceptual Speed	None	

CRITICAL TASK 55

Position: Tank Loader

Task: Operate Fire/Safety Switch

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	None	
Memory	None	

CRITICAL TASK 56

Position: Tank Loader

Task: Advise Gunner When COAX and Main Gun Can Fire

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 57

Position: Tank Loader

Task: Conduct Immediate Action to Correct COAX Malfunction

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Stress	45, 53, 54, 74

CRITICAL TASK 58

Position: Tank Loader

Task: Unload Non-Operational Main Gun Rounds

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Dynamic Precision	None	
Memory	None	

CHAPTER V

FIRE SUPPORT TEAM (FIST) PERFORMANCE

Projected performance degradation in Fire Support Teams (FIST) for duty positions, platoon, and company level teams are summarized. Detailed projections by tasks and defensive (platoon) actions are tabulated. Digests of adverse factors' impacts on 59 critical tasks are provided.

Summary of Consequences for Performance of Continuous Operations

Of the four debilitating factors, fatigue (sleep loss over five days), light level (darkness), stress and disruption of diurnal rhythms, again, fatigue (expressed as mission days) is expected to produce the greatest decrement in the performance of the FIST personnel. However, all tasks performed by the FIST are not affected in the same way. While tasks that are externally (situationally) paced, or have a heavy cognitive or vigilance component can be expected to degrade in proportion to the amount of sleep lost, self-paced activities that are well practiced or routine are likely to show orderly and appropriate reactions with only small performance difficulties as time wears on. Intellective and perceptual tasks, typically performed by the FIST Chief and FO, most severely affected by sleep loss are those involving logical reasoning and requiring accurate perception as well as concentration. Resistance to degradation over time will vary directly with task complexity. For example, "redirecting FO calls for fire" (Task Nos. 18, 58) can be expected to show little deterioration with sleep loss because it requires little mental manipulation of information. On the other hand, performance of target acquisition (Task No. 40) and selection of observation posts (Task Nos. 5, 35) can be expected to exhibit considerable degradation. Even acutely sleep deprived FS NCO's and RTO's probably will adequately perform most of their critical tasks. However, the acutely sleep deprived FIST Chief and FO's may show considerable deterioration in their performance of specific critical tasks as the time of the continuous operation becomes extended in duration. A summary of the projected effectiveness of various FIST duty positions over five days of continuous combat operations, assuming little or no organized sleep, is shown as Figure 5.1. The duty positions shown to degrade most rapidly include the FIST Chief and the FO. Persons in these two duty positions are required to perform many tasks with a heavy cognitive and perceptual loading. In contrast, the tasks peculiar to the FS NCO and the RTO tend to be of a well practiced or routine type.

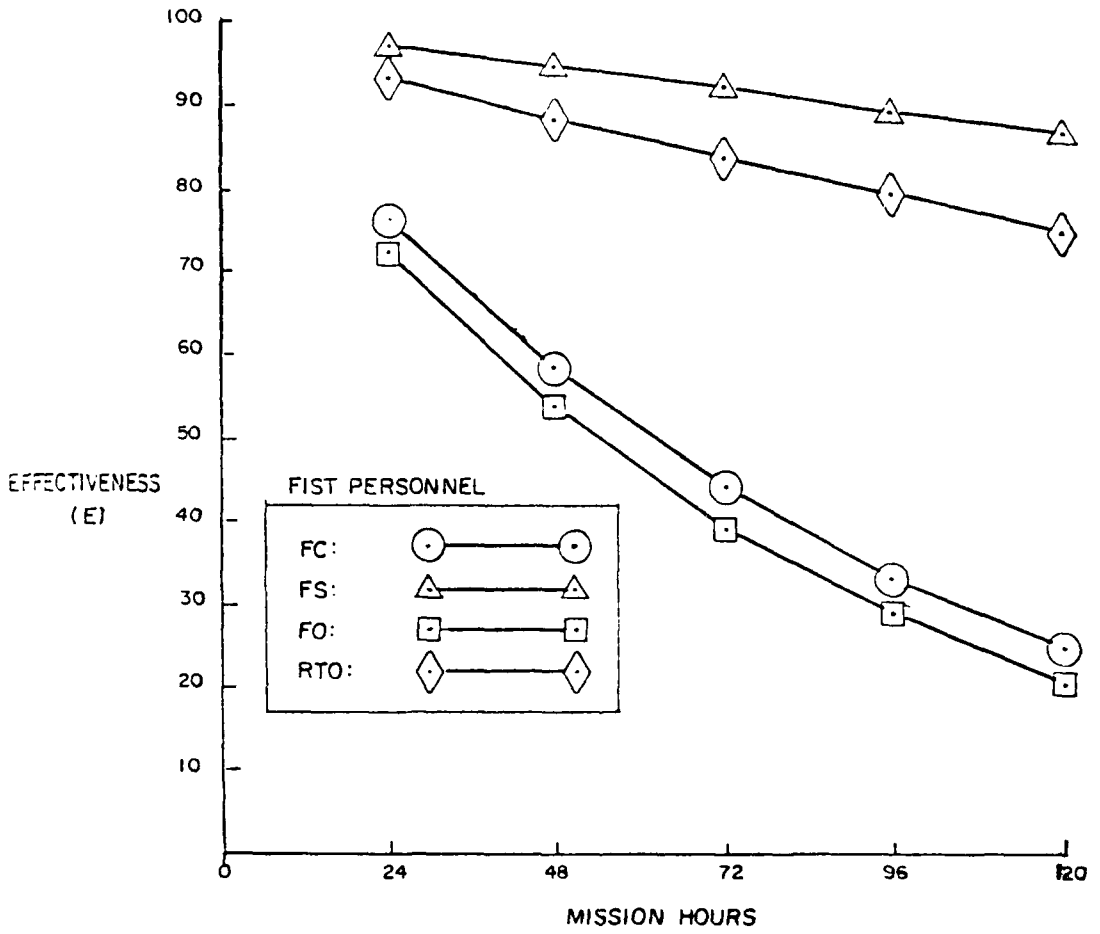


Figure 5.1. Performance degradation in FIST duty positions.
(FC = FIST Chief, FS = Fire Support NCO,
FO = Forward Observer, RTO = Radio Telephone Operator)

Figure 5.2 presents projected performance effectiveness as a function of mission duration for the FIST at company and platoon levels. The graph illustrates that the platoon level degrades more rapidly than the company level.

Figure 5.3 contrasts FIST effectiveness over mission days for "best" and "worst" prevailing conditions of impacting debilitating factors. The graph illustrates that, as before, the influence of the impacting factors (light level, stress, and diurnal rhythms) is less than the influence of fatigue (sleep loss over five days) in degrading performance effectiveness. However, the effect of these other stressors on performance should not be minimized in the thinking of the military planner. Projected effectiveness is also influenced by the number of individuals in the FIST. At the platoon level, FIST normally consists of the FO and the RTO. At the company level, FIST normally consists of three platoon level teams, the FIST Chief, and the FS NCO. However, a somewhat degraded condition of only two platoon level teams was assumed for calculation of the effectiveness values shown in Tables 5.1 and 5.2. Since the scenario (Chapter II) assumed 6 to 1 odds, this seemed to be a realistic premise. Table 5.1 presents the projected effectiveness of each FIST duty position and the team at two organizational levels for the different platoon actions as well as an average across the three types of platoon action and mission days (sleep loss). The projections indicate that wide variations in performance effectiveness can be expected for the different positions and platoon actions. Best and worst performance can range between very effective, e.g., 100 and grossly ineffective, e.g., 21.

Table 5.1

Effectiveness (E) of FIST: Duty Positions, Platoon and Company Level Teams in Different Platoon Actions and Over Mission Days

		Duty Position				Team	
	Day	FC	FO	FS	RTO	Platoon	Company
Platoon Action 1	1	74	73	100	100	85	88
	3	41	38	100	100	62	69
	5	22	20	100	100	45	53
Platoon Action 2	1	82	78	100	92	85	91
	3	55	48	100	78	61	76
	5	37	30	100	65	44	63
Platoon Action 3	1	73	69	92	92	80	85
	3	38	33	78	78	51	60
	5	20	15	65	65	31	42
Platoon Action 1,2,3	1	76	73	97	94	83	88
	3	44	39	92	84	57	68
	5	25	21	87	75	40	52

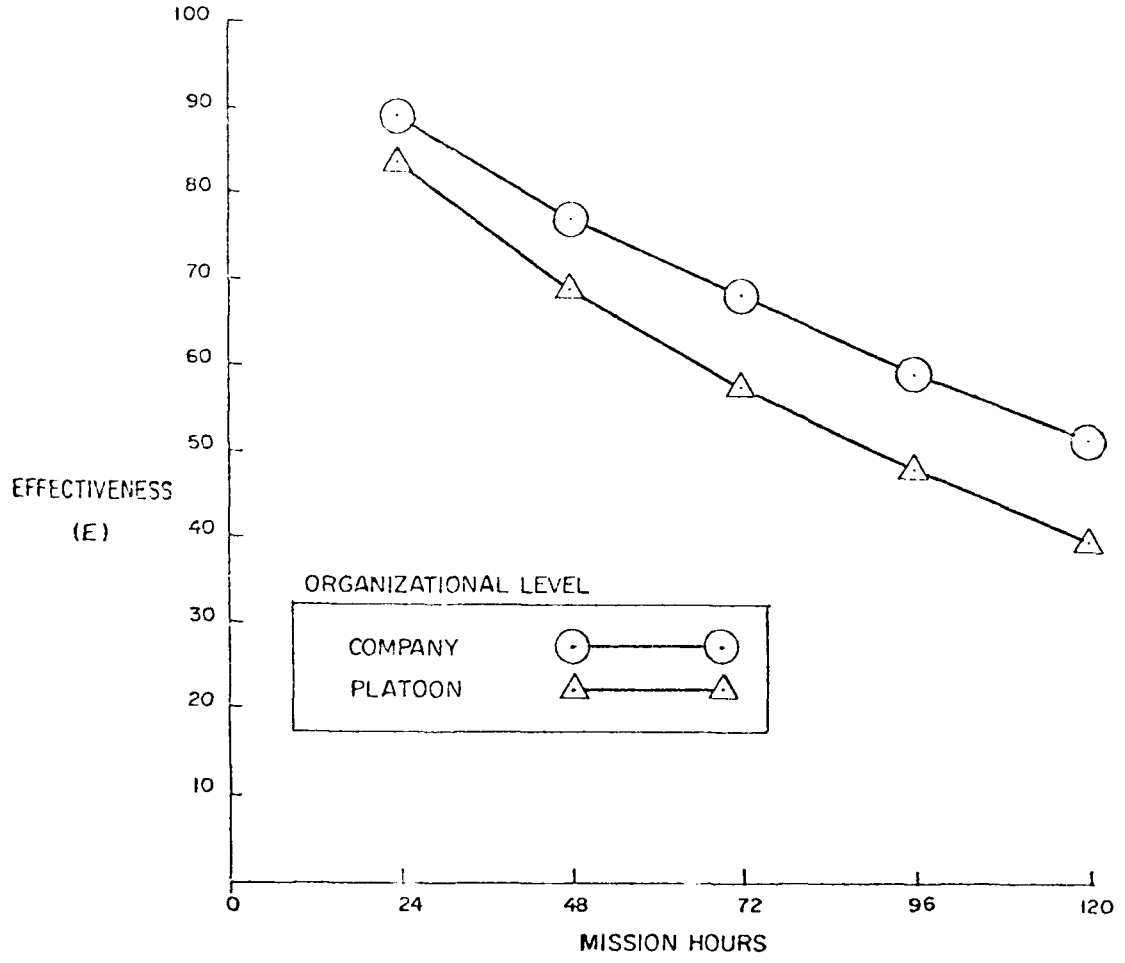


Figure 5.2. FIST: Progressive degradation of effectiveness--platoon and company levels with all adverse factors present.

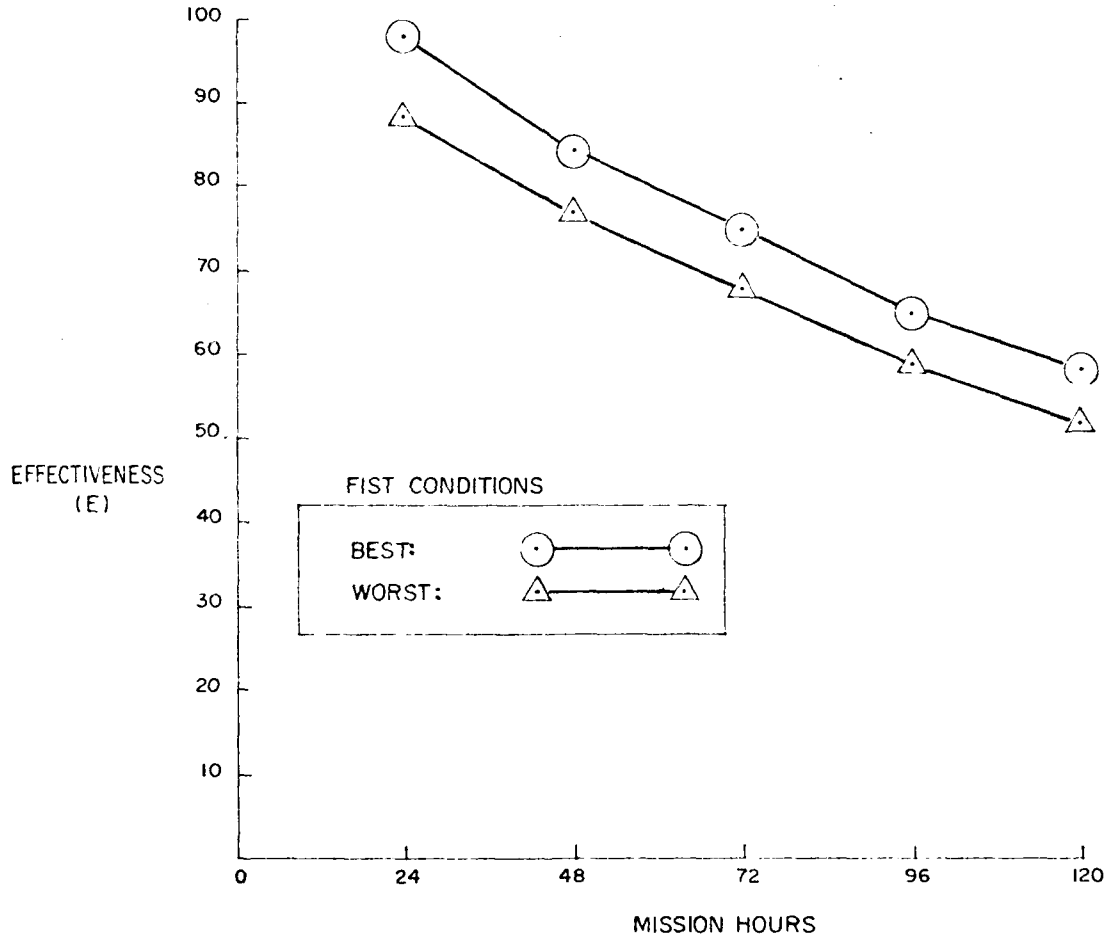


Figure 5.3. FIST: Effectiveness of teams under best and worst conditions.

Table 5.2

Effectiveness (E) of FIST: Duty Positions, Platoon and Company Level Teams Under All Combinations of Adverse Conditions

Impacting Debilitating Factors				Duty Position				FIST	
F	L	S	D	FIST Chief	FSNCO	FO	RTO	Platoon	Company
24	0	0	0	93	100	92	100	96	97
24	0	0	1	90	100	88	100	94	96
24	0	1	0	85	97	84	94	89	92
24	1	0	0	87	100	85	100	92	94
24	0	1	1	82	97	80	94	87	91
24	1	0	1	84	100	81	100	90	93
24	1	1	0	79	97	77	94	85	89
24	1	1	1	76	97	73	94	83	88
48	0	0	0	69	97	67	94	79	84
48	0	0	1	67	97	64	94	78	83
48	0	1	0	64	95	62	89	74	81
48	1	0	0	65	97	62	94	76	82
48	0	1	1	62	95	59	89	72	80
48	1	0	1	63	97	60	94	75	81
48	1	1	0	60	95	57	89	71	79
48	1	1	1	58	95	54	89	69	77
72	0	0	0	54	95	50	89	67	75
72	0	0	1	52	95	47	89	65	74
72	0	1	0	49	92	45	84	61	71
72	1	0	0	50	95	46	89	64	73
72	0	1	1	48	92	43	84	60	70
72	1	0	1	49	95	44	89	63	72
72	1	1	0	46	92	41	84	59	69
72	1	1	1	44	92	39	84	57	68
96	0	0	0	39	92	36	84	55	65
96	0	0	1	39	92	34	84	53	64
96	0	1	0	37	89	33	80	51	62
96	1	0	0	38	92	33	84	53	64
96	0	1	1	36	89	32	80	51	61
96	1	0	1	37	92	32	84	52	63
96	1	1	0	34	89	30	80	49	60
96	1	1	1	33	89	29	80	48	59
120	0	0	0	31	89	27	80	46	58
120	0	0	1	30	89	25	80	45	57
120	0	1	0	28	87	24	75	42	54
120	1	0	0	29	89	25	80	45	56
120	0	1	1	27	87	23	75	42	54
120	1	0	1	28	89	23	80	43	55
120	1	1	0	26	87	22	75	41	53
120	1	1	1	25	87	21	75	40	52

Table 5.2 presents the effectiveness of FIST Duty Position, Platoon level team and Company level team as a function of all combinations of impacting adverse factors over five days of continuous operations. In the Table 5.2, the impacting debilitating factors are coded as follows:

F = Fatigue level in days (1 - 5)

L = Light level: 1 = dark and 0 = light

S = Stress: 1 = stress present and 0 = stress absent

D = Diurnal rhythm: 1 = rhythm out of phase and
0 = rhythm in phase.

As before, the values of E (the effectiveness index) in Table 5.2 represent all possible degrees or combinations in the impact of the debilitating factors on performance. The least degradation occurs with the 24, 0, 0, 0 combination of debilitating factors, and the greatest degradation with 120, 1, 1, 1 combination. Intermediate conditions lie between these extremes. The E values shown in Table 5.2 represent the indicated hour, i.e., the last hour of the first, second, third, fourth, and fifth days of continuous combat operations.

Table 5.3 presents the projected effectiveness (E) for critical combat tasks characteristically performed by the several duty positions in FISTs. Successive parts of Table 5.3 present projected values of E for tasks performed by the FIST Chief, FO, FS NCO, and RTO. Values of E are tabled for each of the three types of defensive platoon actions (Platoon Actions 1, 2, 3) here considered and for the average across the three types. In each case values are given for the (last hour of) first, second, third, fourth, and fifth day of continuous combat operations.

Once again, the variability of effectiveness across tasks and platoon actions represents a dominant data characteristic. This makes general statements about overall performance effectiveness quite tenuous. While the performance of some tasks is anticipated to be degraded only nominally over five days (120 hours) of continuous operations, performance of other tasks will become very quickly degraded to unacceptable levels. Examples of tasks anticipated to be only nominal are: Task No. 58 "redirecting FO calls for fire," and Task No. 59 "operating the field telephone." The FS NCO and RTO respectively normally perform these tasks. Examples of tasks forecast to degrade to an unacceptable level include Task No. 10 "adjusting corrective fires," Tasks Nos. 26, 54 "adjusting multiple missions," and Tasks Nos. 11, 42 "engaging targets of opportunity." These perceptually and cognitively loaded tasks are performed by either the FIST Chief or the FO.

Table 5.4 summarizes the impacts of debilitating factors on critical abilities of FIST personnel relevant to the performance of their critical tasks.

Table 5.3

Projected Effectiveness (E) for Critical Combat Tasks: FIST

FIST: Chief

		Task No.																
	Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Platoon Action$_1$	1	92	85	85	85	100	100	100	78	84	47	56	85	71	47	57	51	100
	2	84	73	73	73	100	100	100	61	71	22	31	73	51	22	32	27	100
	3	78	62	62	62	100	100	100	48	59	10	17	62	36	10	18	14	100
	4	71	53	53	53	100	100	100	37	50	05	10	53	26	05	10	07	100
	5	65	45	45	45	100	100	100	29	42	02	05	45	18	02	06	04	100
Platoon Action$_2$	1	100	100	100	100	92	84	78	85	92	56	74	85	92	56	100	100	100
	2	100	100	100	100	84	71	61	73	84	32	54	73	84	32	100	100	100
	3	100	100	100	100	78	59	48	62	78	18	40	62	78	18	100	100	100
	4	100	100	100	100	71	50	37	53	71	10	29	53	71	10	100	100	100
	5	100	100	100	100	65	42	29	45	65	06	22	45	65	06	100	100	100
Platoon Action$_3$	1	92	85	100	100	65	100	78	78	84	47	56	85	100	47	57	51	85
	2	84	73	100	100	43	100	61	61	71	22	31	73	100	22	32	27	73
	3	78	62	100	100	28	100	48	48	59	10	17	62	100	10	18	14	62
	4	71	53	100	100	18	100	37	37	50	05	10	53	100	05	10	07	53
	5	65	45	100	100	12	100	29	29	42	02	05	45	100	02	06	04	45
Platoon Actions 1, 2, 3	1	94	90	95	95	84	94	85	80	87	50	61	85	87	50	69	64	95
	2	89	81	90	90	71	89	72	65	75	25	37	73	75	25	47	41	99
	3	84	73	85	85	60	84	61	52	65	12	23	62	65	12	32	27	86
	4	80	65	81	81	51	79	52	42	56	06	14	53	57	06	22	17	81
	5	75	59	77	77	43	75	44	34	49	03	08	45	49	03	15	11	77

Table 5.3 (cont.)

FIST: Chief (cont.)

		Task No.											
	Day	18	19	20	21	22	23	24	25	26	27	28	29
Platoon Action$_1$	1	100	100	47	57	57	100	100	60	32	74	100	92
	2	100	100	22	32	32	100	100	37	10	54	100	84
	3	100	100	10	18	18	100	100	22	03	40	100	78
	4	100	100	05	10	10	100	100	13	01	29	100	71
	5	100	100	02	06	06	100	100	08	00	22	100	65
Platoon Action$_2$	1	100	100	51	100	57	100	67	60	32	100	100	92
	2	100	100	27	100	32	100	45	37	10	100	100	84
	3	100	100	14	100	18	100	30	22	03	100	100	78
	4	100	100	07	100	10	100	20	13	01	100	100	71
	5	100	100	04	100	06	100	13	08	00	100	100	65
Platoon Action$_3$	1	92	71	47	100	52	47	100	60	32	100	100	92
	2	84	51	22	100	27	22	100	37	10	100	100	84
	3	78	36	10	100	14	10	100	22	03	100	100	78
	4	71	26	05	100	07	05	100	13	01	100	100	71
	5	65	18	02	100	04	02	100	08	00	100	100	65
Platoon Actions 1, 2, 3	1	97	89	48	83	55	78	87	60	32	90	100	92
	2	95	80	23	69	31	60	76	37	10	82	100	84
	3	92	71	11	57	17	47	67	22	03	74	100	78
	4	89	64	05	47	09	36	58	13	01	67	100	71
	5	87	57	03	39	05	28	51	08	00	60	100	65

Table 5.3 (cont.)

FIST: Forward Observer

Task No.

	Day	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46
Platoon Action$_1$	1	92	92	85	85	100	65	100	78	72	61	78	78	56	85	100	47	100
	2	84	84	73	73	100	43	100	61	52	37	61	61	31	73	100	22	100
	3	78	78	62	62	100	28	100	48	37	23	48	48	17	62	100	10	100
	4	71	71	53	53	100	18	100	37	27	14	37	37	10	53	100	05	100
	5	65	65	45	45	100	12	100	29	19	08	29	29	05	45	100	02	100
Platoon Action$_2$	1	100	92	100	85	100	78	78	85	85	78	78	78	74	85	71	56	100
	2	100	84	100	73	100	61	61	73	73	61	61	61	54	73	51	32	100
	3	100	78	100	62	100	48	48	62	62	48	48	48	40	62	36	18	100
	4	100	71	100	53	100	37	37	53	53	37	37	37	29	53	26	10	100
	5	100	65	100	45	100	29	29	45	45	29	29	29	22	45	18	06	100
Platoon Action$_3$	1	92	92	100	85	100	65	78	78	72	61	78	78	56	85	71	47	57
	2	84	84	100	73	100	43	61	61	52	37	61	61	31	73	51	22	32
	3	78	78	100	62	100	28	48	48	37	23	48	48	17	62	36	10	18
	4	71	71	100	53	100	18	37	37	27	14	37	37	10	53	26	05	10
	5	65	65	100	45	100	12	29	29	19	08	29	29	05	45	18	02	06
Platoon Actions 1, 2, 3	1	94	92	95	85	100	69	85	80	76	66	78	78	61	85	80	50	83
	2	89	84	90	73	100	48	72	65	58	44	61	61	37	73	64	25	69
	3	84	78	85	62	100	34	61	52	44	29	48	48	23	62	51	12	57
	4	80	71	81	53	100	23	52	42	34	19	37	37	14	53	41	06	47
	5	75	65	77	45	100	16	44	34	26	13	29	29	08	45	32	03	39

Table 5.3 (cont.)

FIST: Forward Observer (cont.)

		Task No.									
	Day	47	48	49	50	51	52	53	54	55	56
Platoon Action$_1$	1	47	47	62	52	100	100	60	32	74	92
	2	22	22	38	27	100	100	37	10	54	84
	3	10	10	23	14	100	100	22	03	40	78
	4	05	05	14	07	100	100	13	01	29	71
	5	02	02	09	04	100	100	08	00	22	65
Platoon Action$_2$	1	100	51	100	57	100	67	60	32	100	92
	2	100	27	100	32	100	45	37	10	100	84
	3	100	14	100	18	100	30	22	03	100	78
	4	100	07	100	10	100	20	13	01	100	71
	5	100	04	100	06	100	13	08	00	100	65
Platoon Action$_3$	1	47	47	62	52	47	100	60	32	100	92
	2	22	22	38	27	22	100	37	10	100	84
	3	10	10	23	14	10	100	22	03	100	78
	4	05	05	14	07	05	100	13	01	100	71
	5	02	02	09	04	02	100	08	00	100	65
Platoon Actions 1, 2, 3	1	60	48	72	54	78	87	60	32	90	92
	2	36	23	53	29	60	76	37	10	82	84
	3	22	11	38	15	47	67	22	03	74	78
	4	13	05	28	08	36	58	13	01	67	71
	5	08	03	20	04	28	51	08	00	60	65

Table 5.3 (cont.)

FIST: 1. Fire Support NCO

	Day	Task No. 57	Task No. 58
Platoon Action$_1$	1	100	100
	2	100	100
	3	100	100
	4	100	100
	5	100	100
Platoon Action$_2$	1	100	100
	2	100	100
	3	100	100
	4	100	100
	5	100	100
Platoon Action$_3$	1	92	92
	2	84	84
	3	78	78
	4	71	71
	5	65	65
Platoon Actions 1, 2, 3	1	97	97
	2	95	95
	3	92	92
	4	89	89
	5	87	87

2. Radio Telephone Operator

Task No. 59
100
100
100
100
100
92
84
78
71
65
92
84
78
71
65
94
89
84
80
75

Table 5.4

FIST: Summary of Significant Depressions of Critical Abilities

	TASK NO.	FATIGUE						DIURNAL RHYTHM		LIGHT LEVEL				STRESS			
		V	H	NF	R	PS	2	NF	R	V	H	DP	2	M	R	PS	2
FIST CHIEF	1													1 3			
	2														1 3		1 3
	3				1												1
	4				1												1
	5				3		3		3				23		3		
	6				2				2								
	7						23			23			23				
	8						1 3			123			123				
	9						1 3						123				
	10	123		123			123	123		123			123		1 3	123	1 3
	11				123		1 3		1 3	123			123		1 3	123	
	12									123			123				
	13				1				1	12					1		
	14	123		123			123	123		123			123		1 3	123	1 .
	15	1 3		1 3				1 3		1 3					1 3	1 3	1 3
	16	1 3		1 3			1 3	1 3		1 3			1 3			1 3	1 3
	17														3		.
	18																.
	19				3				3						3		.
	20	123		123			123	123		123			123		1 3	123	12.
	21	1		1				1		1						1	1
	22			123			123	123		123			123		1 3	123	12.
	23	3		3			3	3		3			3		3	3	.
	24			2			2	2					2				2
	25			123	123			123	123						123		12.
	26	123		123		123	123	123	123	123			123	123	123	123	12
	27									1				1		1	1
	28																
	29																12
FORWARD OBSERVER	30													1 3			
	31													123			
	32														1		1
	33														123		12
	34																
	35				1 3		123		1 3				123		123		
	36						23			23			23				
	37						1 3			123			123				
	38			123			1 3	1 3					123				
	39	1 3				1 3	1 3			123			123			123	
	40			123				123		123							
	41			123				123		123							
	42				123		1 3		1 3	123			123		1 3	123	
	43									123			123				
	44				23				23	23					23		
	45	123		123			123	123		123			123		1 3	123	1
	46	3		3				3		3					3	3	
	47	1 3		1 3			1 3	1 3		1 3			1 3		1 3	1 3	1 .
	48	123		123			123	123		123			123		1 3	123	12.
	49	1 3		1 3				1 3		1 3						1 3	1 .
	50			123			123	123		123			123		1 3	123	12.
	51	3		3			3	3		3			3		3	3	.
	52			2			2	2					2				2
	53			123	123			123	123						123		12.
	54	123		123		123	123	123	123	123			123	123	123	123	12.
	55									1				1		1	1
	56																12.
FIRE SUPPORT NCO	57													3			
	58																
RADIO TELEPHONE OPERATOR	59													23			

The table heading shows the abilities (see Taxonomy in Chapter I) needed for task performance and the debilitating factors (see Chapter I) impacting on these abilities. Only the impacts are recorded in the body of the table. That is, the absence of an entry may be due to the fact that (a) the task in question is not critical in the given platoon action, (b) the ability in question is not critical for the given task, or (c) the ability in question is not depressed in this task and platoon action. Where there is an entry in the body of the table, a "1" denotes a significant (greater than 20%) depression of the ability in Platoon Action 1, a "2" denotes the same for Platoon Action 2, and a "3" for Platoon Action 3.

As well as a descriptive summary of adversely affected critical abilities in critical tasks, Table 5.4 serves as a cross index to yield information such as:

a. critical tasks performed by various duty positions

b. source(s) of adverse impacts on critical abilities

c. adversely affected (depressed) critical abilities in critical tasks

d. adversely affected tasks in platoon actions

e. combinations of the above.

Note that Table 5.4 is derived from findings which indicated that all debilitating factors do not affect all abilities. The relationship between debilitating factors and the critical abilities on which they act was summarized in Table 3.5 (in Chapter III).

Digest of Critical Tasks and Their Performance

As for the prior sections of this volume, succeeding sections of this chapter present a task by task summary of the variables which affect FIST task performance during continuous operations. The compendium attempts to summarize for each duty position, and critical FIST task within position, the critical ability or abilities necessary for successful task performance and to state which debilitating factor(s) will affect performance of the task. For example, the FIST Chief's Task No. 15, "adjusting counterfire mission," requires the critical abilities of Vision, Numerical Facility, Reasoning, Perceptual Speed, and Communication, which are affected by Fatigue, Light Level (Darkness, etc.) Diurnal Rhythms, and Stress.

The relationships between a critical ability and one of the unique conditions of continuous operation are presented in Chapter III on the Mechanized Infantry. The Chapter III implications apply equally to the case of the FIST. The interpretations and implications are also the same.

Table 5.5

FIST: Index of Discussions of Effects of Debilitating Factors on Critical Abilities

Debilitating Factor	Critical Ability	Discussed Under Mechanized Infantry Task No. (Ch. III)
Fatigue	Vision	1, 30, 33
	Hearing	19, 33
	Numerical Facility	57, 66, 68
	Reasoning	57, 66, 68, 74
	Perceptual Speed	29, 30, 57
	Orientation	7, 29, 33
Diurnal Rhythm	Numerical Facility	11, 57, 61
	Reasoning	11, 57, 61
Light Level	Vision	9, 26, 44, 72
	Hearing	22, 33
	Dynamic Precision	18, 20
	Orientation	7
Stress	Memory	56, 69
	Reasoning	45, 53, 54, 74
	Perceptual Speed	2, 6
	Communication	48

NOTES: 1. Task Nos. in body of table refer to task digests appearing in Chapter III.

2. Discussion in task digests are relevant to Armor, Artillery and FIST where common abilities are required.

CRITICAL TASK 1

Position: FIST Chief

Task: Receive Orders and Plans from TM CDR

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	Stress	56, 69

CRITICAL TASK 2

Position: FIST Chief

Task: Coordinate with TM CDR

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 3

Position: FIST Chief

Task: Coordinate with PLs

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
Communication	Stress	48

CRITICAL TASK 4

Position: FIST Chief

Task: Coordinate with FSO

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
Communication	Stress	48

CRITICAL TASK 5

Position: FIST Chief

Task: Select Observation Posts

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Stress	45, 53, 54, 74
	Diurnal Rhythm	11, 57, 61
Orientation	Light Level/Visibility	7

CRITICAL TASK 6

Position: FIST Chief

Task: Plan WPN SYS Round, FUZE, MOE & MOC for Each Target

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61

CRITICAL TASK 7

Position: FIST Chief

Task: Operate Laser Locator-Designator

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 8

Position: FIST Chief

Task: Orient for Direction

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 9

Position: FIST Chief

Task: Determine Exact Position on the Ground

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 10

Position: FIST Chief

Task: Adjust Corrective Fires

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 11

Position: FIST Chief

Task: Engage Targets of Opportunity

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Stress	2, 6

CRITICAL TASK 12

Position: FIST Chief

Task: Adjust CLGP (Laser)

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Orientation	Light Level/Visibility	7

CRITICAL TASK 13

Position: FIST Chief

Task: Determine When to Request End of Mission

Highly Critical in Platoon Actions: 1, 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 14

Position: FIST Chief

Task: Adjust ICM Mission

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 15

Position: FIST Chief

Task: Adjust Counterfire Mission

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 16

Position: FIST Chief

Task: Adjust Immediate Suppression

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 17

Position: FIST Chief

Task: Approve FO Calls for Fire

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 18

Position: FIST Chief

Task: Redirect FO Calls for Fire

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 19

Position: FIST Chief

Task: Request FSO Provide GS Artillery Support

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 20

Position: FIST Chief

Task: Adjust TACAIR

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 21

Position: FIST Chief

Task: Adjust High Burst

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 22

Position: FIST Chief

Task: Adjust Attack Helicopters

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 23

Position: FIST Chief

Task: Adjust Mortars

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 24

Position: FIST Chief

Task: Adjust Communication

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 25

Position: FIST Chief

Task: Adjust Danger Close

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 26

Position: FIST Chief

Task: Adjust Multiple Missions

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 27

Position: FIST Chief

Task: Report Target Engagement Results

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 28

Position: FIST Chief

Task: Order Relocation of FIST

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	None	
Numerical Facility	None	
Orientation	None	
Reasoning	None	

CRITICAL TASK 29

Position: FIST Chief

Task: Relay Calls for Fire

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 30

Position: Forward Observer

Task: Receive Plans and Orders from FIST Chief

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	Stress	56, 69

CRITICAL TASK 31

Position: Forward Observer

Task: Receive Plans and Orders from PL

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	Stress	56, 69

CRITICAL TASK 32

Position: Forward Observer

Task: Coordinate with FIST Chief

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 33

Position: Forward Observer

Task: Coordinate with PL

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 34

Position: Forward Observer

Task: Coordinate with FDC

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	None	
Hearing	None	
Memory	None	
Numerical Facility	None	
Orientation	None	
Reasoning	None	
Vision	None	

CRITICAL TASK 35

Position: Forward Observer

Task: Select Observation Posts

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 36

Position: Forward Observer

Task: Operate Laser Locator-Designator

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	*Adverse Factor(s)*	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 37

Position: Forward Observer

Task: Orient for Directions

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 38

Position: Forward Observer

Task: Determine Exact Location on the Ground

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 39

Position: Forward Observer

Task: Acquire Targets

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 40

Position: Forward Observer

Task: Determine Range of Target

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 41

Position: Forward Observer

Task: Determine Direction of Target

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 42

Position: Forward Observer

Task: Engage Targets of Opportunity

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Stress	2, 6

CRITICAL TASK 43

Position: Forward Observer

Task: Adjust CLGP

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Orientation	Light Level/Visibility	7

CRITICAL TASK 44

Position: Forward Observer

Task: Determine When to Request End of Mission

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 45

Position: Forward Observer

Task: Adjust ICM Missions

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 46

Position: Forward Observer

Task: Adjust Counterfire Mission

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 47

Position: Forward Observer

Task: Adjust Immediate Suppressive Fires

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 48

Position: Forward Observer

Task: Adjust TACAIR

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 49

Position: Forward Observer

Task: Adjust High Burst Missions

Highly Critical in Platoon Actions: 1, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 50

Position: Forward Observer

Task: Adjust Attack Helicopters

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 51

Position: Forward Observer

Task: Adjust Mortars

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Stress	45, 53, 54, 74
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 52

Position: Forward Observer

Task: Adjust Illumination

Highly Critical in Platoon Actions: 2

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 53

Position: Forward Observer

Task: Adjust Danger Close

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Reasoning	Fatigue	57, 66, 68, 74
	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 54

Position: Forward Observer

Task: Adjust Multiple Missions

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Perceptual Speed	Fatigue	29, 30, 57
	Stress	2, 6
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Reasoning	Diurnal Rhythm	11, 57, 61
	Stress	45, 53, 54, 74
Memory	Stress	56, 69
Communication	Stress	48

CRITICAL TASK 55

Position: Forward Observer

Task: Report Target Engagement Results

Highly Critical in Platoon Actions: 1

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69
Perceptual Speed	Stress	2, 6
Communication	Stress	48

CRITICAL TASK 56

Position: Forward Observer

Task: Relay Calls for Fire

Highly Critical in Platoon Actions: 1, 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 57

Position: Fire Support NCO

Task: Receive Plans and Orders from FIST Chief

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	Stress	56, 69

CRITICAL TASK 58

Position: Fire Support NCO

Task: Redirect FO Calls for Fire

Highly Critical in Platoon Actions: 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 59

Position: Radio Telephone Operator (RTO)

Task: Operate Field Telephone

Highly Critical in Platoon Actions: 2, 3

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	Stress	56, 69

CHAPTER VI

ARTILLERY BATTERY PERFORMANCE

Projected performance degradation of 155mm artillery batteries for duty positions, gun crews, and batteries are summarized. Detailed projections by tasks over three levels of intensity of demand are tabulated. Digests of adverse factors' impacts on 48 critical tasks are provided.

Summary of Consequences for Performance of Continuous Operations

As repeatedly noted before, fatigue (loss of sleep over 120 hours) will progressively dominate over and ultimately dwarf the effects of adverse visibility, stress, and disrupted diurnal rhythms. In fact, the adverse effects of the disrupted diurnal rhythms may be diminishing after, perhaps, 72 hours, but this will be so masked by fatigue as to be undetectable. While all personnel, regardless of rank or personal characteristics, are affected in substantially the same way, all tasks performed by these persons are not affected equally.

Tasks making a heavy demand on intellectual (cognitive) abilities or demanding attention or vigilance tend to become most degraded by fatigue. Also, tasks whose pace is set by the surrounding conditions, as opposed to self-initiated and paced tasks tend to suffer greater deterioration. However, "mechanical" tasks, i.e., motor tasks that are very highly practiced, remains surprisingly proof against the deterioration otherwise produced by loss of sleep.

Cognitive and perceptual tasks play an important part in the functioning of the Battery Executive Officer, Howitzer Section Chief, and Gunner. Accordingly, sleep loss is expected to begin degrading tasks that involve logical reasoning and require accurate perception as well as concentration even after the first day (24 hours) without sleep. However, many of the routine tasks performed by the crew members are extremely resistant to sleep loss. Even accutely sleep deprived crew members are likely to perform most of their critical tasks effectively for extended periods without organized sleep. A summary of projected effectiveness of various positions of artillery personnel over five days (120 hours) of continuous operations, assuming little or no organized sleep, is presented as Figure 6.1. The duty positions in which performance can be anticipated to degrade most rapidly are: Battery Executive Officer, Howitzer Section Chief, and

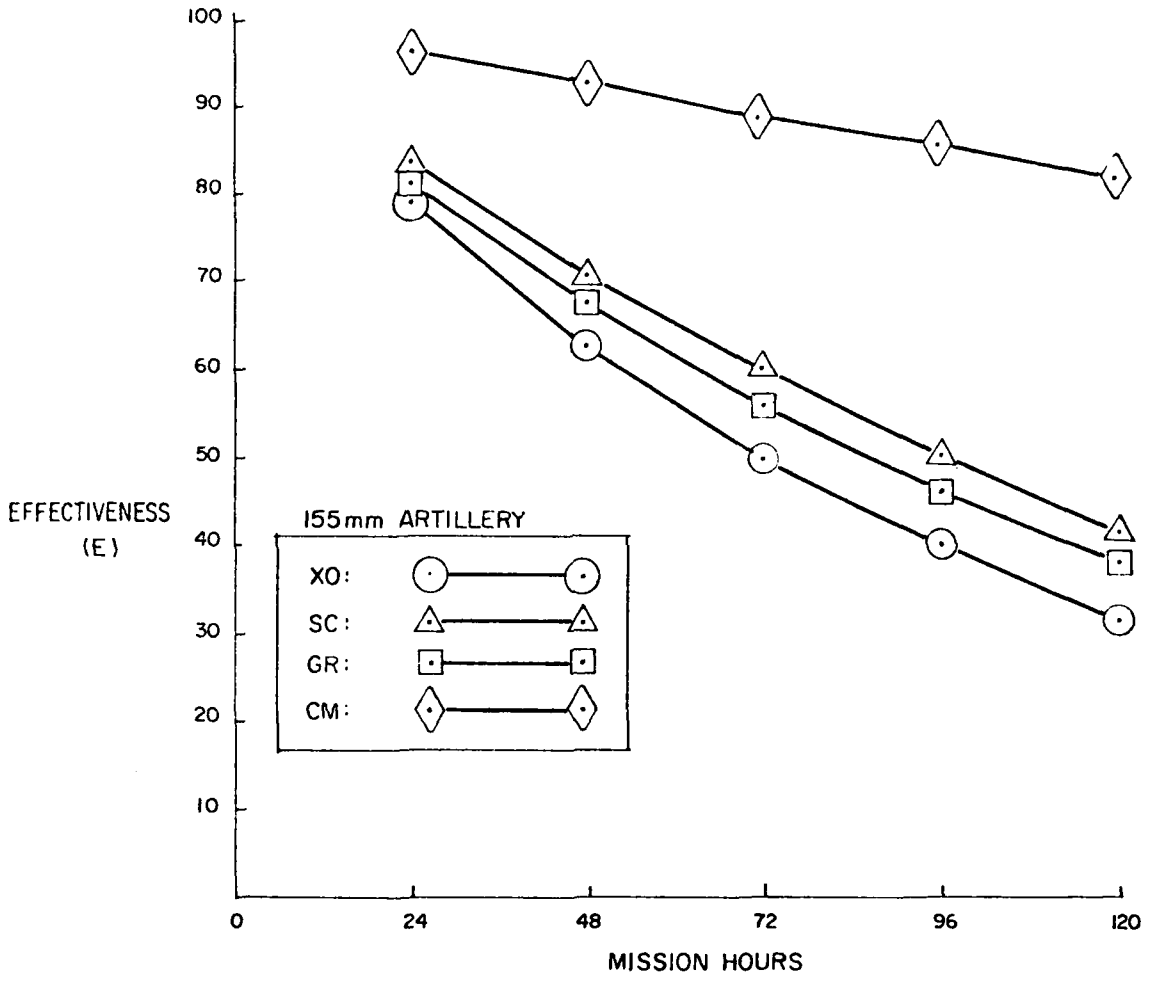


Figure 6.1. Artillery: Progressive degradation of effectiveness--duty positions.
(XO = Executive Officer, SC = Howitzer Section Chief, GR = 155 mm Gunner, CM = 155 Crew Member)

and Gunner. Persons in these three duty positions are required to perform critical tasks which possess heavy cognitive and perceptual loading. In contrast, the crew members perform many physical tasks that are usually well practiced, routine, and not intellectively involving. Accordingly, their performance will be degraded only nominally. Figure 6.2 depicts projected overall performance effectiveness as a function of mission duration for an individual 155mm SP Artillery crew and for a Battery. The graph illustrates that the two degrade at about the same rate. Figure 6.3 contrasts Battery effectiveness over mission days for the "best" and the "worst" conditions of impacting debilitating factors.

Projected effectiveness is also influenced by the number of individuals and the number of 155mm SP pieces available. While a 155mm Artillery Battery normally consists of six howitzers, a considerably degraded condition of only three howitzers was assumed for calculation of the effectiveness values shown in Tables 6.1 and 6.2. Since the scenario (Chapter II) assumed 6 to 1 odds, this seemed to be a realistic premise. However, each piece was assumed to have a complete crew consisting of a Section Chief, a Gunner, and three crew members.

Table 6.1

Effectiveness (E) of Artillery: Duty Positions, Individual Crew, and Battery with Different Demand Levels and Over Mission Days

		Position				Artillery	
DEMAND	DAYS	XO	SC	GR	CM	Howitzer	Battery
	1	96	93	92	100	95	97
LO	3	88	82	79	100	87	92
	5	81	71	68	100	79	87
	1	76	82	78	95	86	85
MED	3	44	55	47	86	63	61
	5	25	37	29	77	47	44
	1	69	78	77	94	84	81
HI	3	33	47	46	82	59	53
	5	16	28	28	72	42	35
	1	80	84	82	96	88	88
AVERAGE	3	50	60	56	89	69	67
L,M,H	5	32	42	38	82	53	51

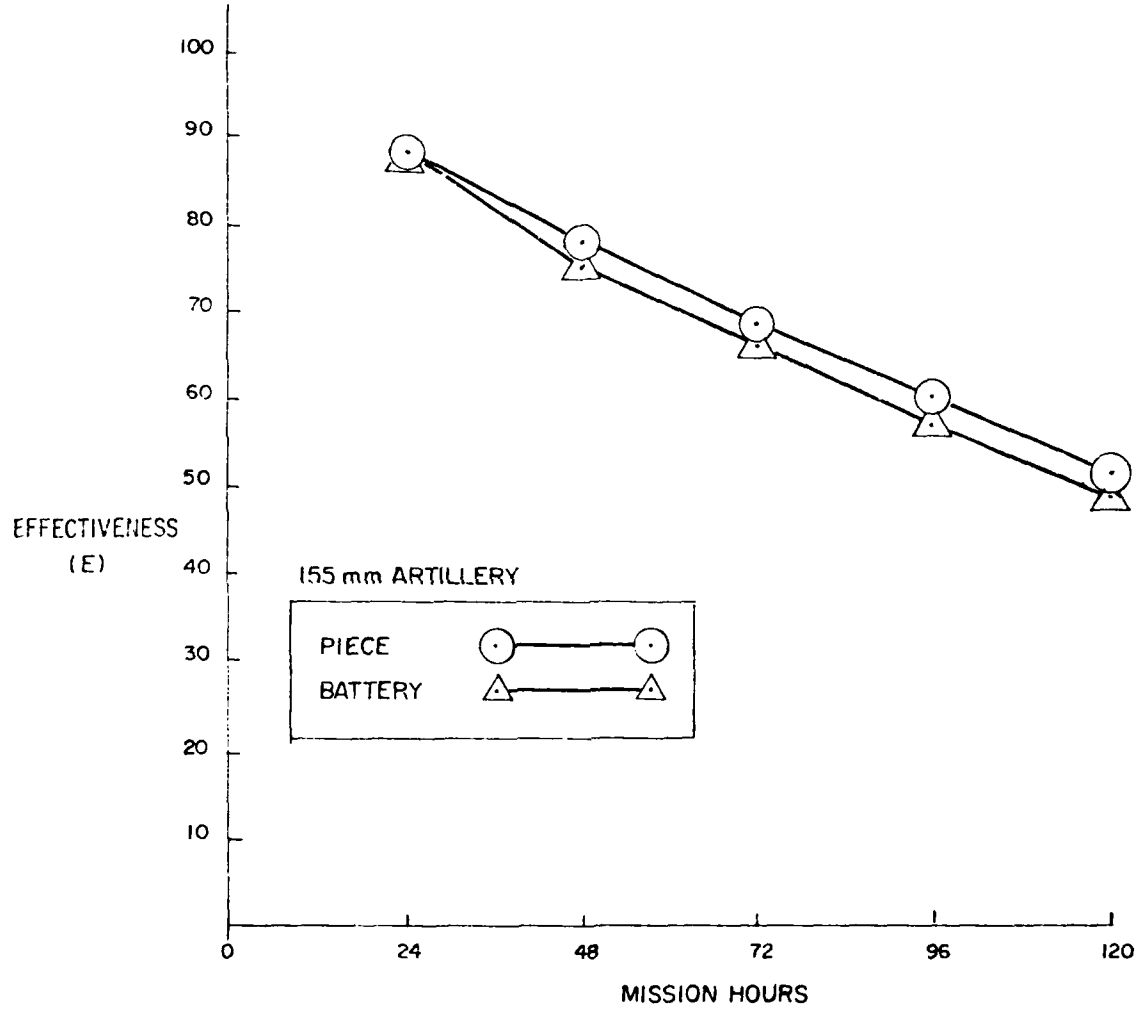


Figure 6.2. Artillery: Progressive degradation of effectiveness--pieces and batteries with all adverse factors present.

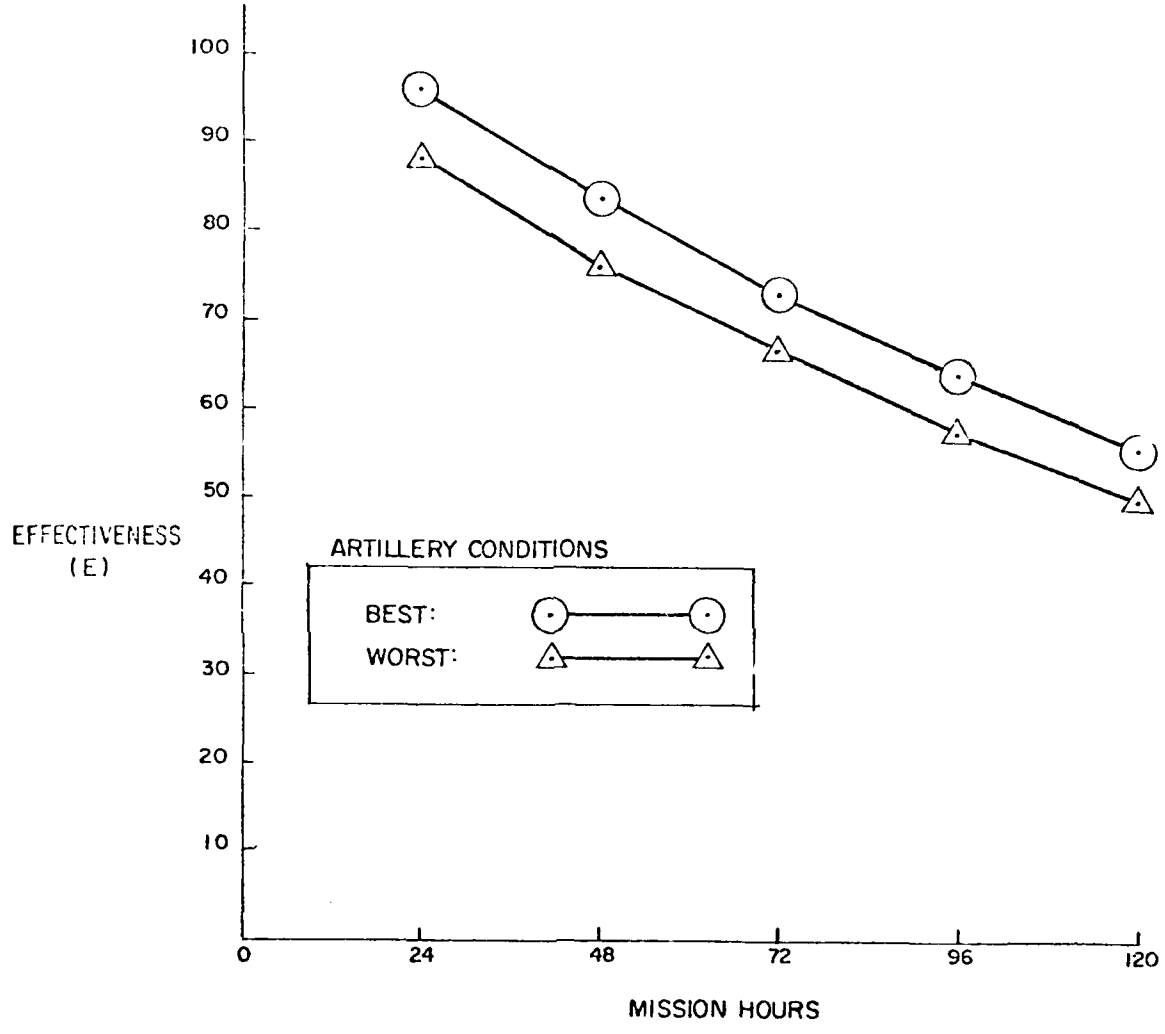


Figure 6.3. Artillery: Effectiveness of batteries under best and worst conditions.

Table 6.2

Effectiveness (E) of Artillery: Duty Positions, Pieces, and Batteries Under All Combinations of Adverse Conditions

Impacting Debilitating Factors				Duty Position				Artillery	
F	L	S	D	XO	SC	GR	CM	Piece	Battery
24	0	0	0	94	97	93	99	97	96
24	0	0	1	92	94	91	99	95	95
24	0	1	0	88	93	92	98	95	93
24	1	0	0	88	90	85	98	91	92
24	0	1	1	86	91	90	98	93	92
24	1	0	1	86	87	83	98	90	91
24	1	1	0	82	86	84	96	89	89
24	1	1	1	80	84	82	96	88	88
48	0	0	0	75	81	76	95	85	84
48	0	0	1	73	79	75	95	84	83
48	0	1	0	70	78	76	94	84	81
48	1	0	0	70	75	70	94	80	81
48	0	1	1	68	76	74	94	82	80
48	1	0	1	68	73	69	94	79	79
48	1	1	0	65	73	70	93	79	78
48	1	1	1	63	71	68	93	78	76
72	0	0	0	59	68	63	92	75	73
72	0	0	1	58	67	62	92	74	72
72	0	1	0	55	66	63	91	74	71
72	1	0	0	55	64	58	91	71	70
72	0	1	1	54	65	61	91	73	70
72	1	0	1	54	64	57	91	71	69
72	1	1	0	51	62	57	89	70	67
72	1	1	1	50	60	56	89	69	67
96	0	0	0	47	57	52	88	66	64
96	0	0	1	46	56	48	88	64	63
96	0	1	0	44	55	52	87	65	62
96	1	0	0	44	53	48	87	63	61
96	0	1	1	43	54	50	87	64	61
96	1	0	1	43	52	47	87	62	61
96	1	1	0	41	51	47	86	61	59
96	1	1	1	40	50	46	86	61	58
120	0	0	0	38	48	43	85	58	56
120	0	0	1	37	47	42	85	58	56
120	0	1	0	35	46	42	84	57	54
120	1	0	0	35	44	39	84	55	54
120	0	1	1	34	45	42	84	57	53
120	1	0	1	34	43	38	84	54	53
120	1	1	0	33	43	39	82	54	52
120	1	1	1	32	42	38	82	53	51

Table 6.1 presents the projected effectiveness of each Artillery duty position, an individual Howitzer Crew, and the Battery for different levels of demand and mission days. The demands considered in the table are low, medium and high levels of Battery activity. Wide variation in performance effectiveness can be expected for different levels of demand, mission days, and duty positions. Best and worst performance is forecast to range between very effective (i.e., 100) and grossly in effective (i.e., 16) as a function of different conditions.

Table 6.2 presents the forecast effectiveness by Artillery Duty Position, individual Howitzer crew, and Battery as a function of all combinations of impacting adverse factors over five days (120 hours) of continuous operations. In Table 6.2, impacting factors are coded as follows: F = Fatigue level in days (1-5); L = Light level: 1 = dark and 0 = light; S = Stress: 1 =stress present and 0 = stress absent; D = Diurnal Rhythm: 1 = rhythm out of phase and 0 = rhythm in phase. For the 155mm Artillery, rather than by platoon actions, differentiation is in terms of the level of demand on the firing Battery: Low = Battery firing in support of a unit preparing a defensive position; Medium = Battery firing in support of a unit under attack; Heavy = Battery and supported unit are under attack (counter battery fire). The projections suggest that here, as for other types of units, fatigue (sleep loss over mission days) is more important in degrading performance over five days than any of the other factors.

Here, again, values of E (the effectiveness index) in Table 6.2 represent all possible degrees or combinations in the impact of the debilitating factors on performance. The least degradation occurs with the 24, 0, 0, 0 combination of debilitating factors, and the greatest degradation with 120, 1, 1, 1. Intermediate conditions lie between these extremes. The E values shown in Table 6.2 represent the indicated hour, i.e., the last hour of the first, second, third, fourth and fifth days of continuous combat operations.

Table 6.3 presents the projected effectiveness (E) for critical combat tasks characteristically performed by the several duty positions in a firing 155mm Battery. Successive parts of Table 6.3 present projected values of E for tasks performed by the Battery Executive Officer (XO), Howitzer Section Chief (How SC), 155mm Gunner (GR), and 155mm Crew Member (CM). Values of E are tabled for three degrees of demand: (1) the Battery is firing in support of a unit under attack (Medium), (2) the Battery is firing in support of a unit preparing a defensive position (Low), and (3) the Battery as well as supporting the unit being under attack, the Battery is forced to displace to avoid the effects of counter battery fire (Heavy). Also, the average across the three levels of demand is shown. In each case, values are given for the (last hour of) first, second, third, fourth and fifth day of continuous combat operations.

Table 6.3

Projected Effectiveness (E) for Critical Combat Tasks: Artillery

Battery Executive Officer

		Task No.					
	Day	1	2	3	4	5	6
Low	1	92	92	100	92	100	100
	2	84	84	100	84	100	100
	3	78	78	100	78	100	100
	4	71	71	100	71	100	100
	5	65	65	100	65	100	100
Medium	1	92	72	84	41	92	92
	2	84	52	71	17	84	84
	3	78	37	59	07	78	78
	4	71	27	50	03	71	71
	5	65	19	42	01	65	65
Heavy	1	85	72	78	37	87	73
	2	73	52	61	14	76	53
	3	62	37	48	05	66	38
	4	53	27	37	02	57	28
	5	45	19	29	01	50	20
Average	1	90	78	87	52	92	87
	2	80	61	76	27	85	76
	3	72	48	66	14	78	67
	4	64	37	57	07	72	58
	5	58	29	50	04	67	51

NOTE: For artillery, differentiation is not in Platoon Actions (PAs) but by degree of demand. Low implies no pressure on firing units; medium implies support of line units under pressure; heavy implies firing unit as well as line unit are under pressure.

Table 6.3 (Cont.)

Howitzer Section Chief

		Task No.										
	Day	7	8	9	10	11	12	13	14	15	16	17
Low	1	100	100	92	85	92	100	100	100	78	84	100
	2	100	100	84	73	84	100	100	100	61	71	100
	3	100	100	78	62	78	100	100	100	48	59	100
	4	100	100	71	53	71	100	100	100	37	50	100
	5	100	100	65	45	65	100	100	100	29	42	100
Medium	1	100	85	61	73	84	100	100	100	73	67	73
	2	100	73	37	53	71	100	100	100	53	45	53
	3	100	62	23	38	59	100	100	100	38	30	38
	4	100	53	14	28	50	100	100	100	28	20	28
	5	100	45	08	20	42	100	100	100	20	13	20
Heavy	1	92	85	61	67	78	92	92	92	73	67	67
	2	84	73	37	45	61	84	84	84	53	45	46
	3	78	62	23	30	48	78	78	78	38	30	31
	4	71	53	14	20	37	71	71	71	28	20	21
	5	65	45	08	13	29	65	65	65	20	13	14
Average	1	97	90	70	74	85	97	97	97	74	72	79
	2	95	81	49	56	72	95	95	95	56	52	62
	3	92	73	34	41	60	92	92	92	41	37	49
	4	89	65	24	31	51	89	89	89	31	27	39
	5	87	59	17	23	43	87	87	87	23	19	31

Table 6.3 (Cont.)

155mm Gunner

Task No.

	Day	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
Low	1	92	100	92	100	92	92	92	92	100	100	92	100	85	84	85	85	92
	2	84	100	84	100	84	84	84	84	100	100	84	100	73	71	73	73	84
	3	78	100	78	100	78	78	78	78	100	100	78	100	62	59	62	62	78
	4	71	100	71	100	71	71	71	71	100	100	71	100	53	50	53	53	71
	5	65	100	65	100	65	65	65	65	100	100	65	100	45	42	45	45	65
Medium	1	72	85	67	85	78	78	84	78	78	84	78	92	72	84	73	73	67
	2	52	73	45	73	61	61	71	61	61	71	61	84	52	71	53	53	45
	3	37	62	30	62	48	48	59	48	48	59	48	78	37	59	38	38	30
	4	27	53	20	53	37	37	50	37	37	50	37	71	27	50	28	28	20
	5	19	45	13	45	29	29	42	29	29	42	29	65	19	42	20	20	13
Heavy	1	72	85	67	85	78	78	84	78	78	84	78	84	72	84	73	73	67
	2	52	73	45	73	61	61	71	61	61	71	61	71	52	71	53	53	45
	3	37	62	30	62	48	48	59	48	48	59	48	59	37	59	38	38	30
	4	27	53	20	53	37	37	50	37	37	50	37	50	27	50	28	28	20
	5	19	45	13	45	29	29	42	29	29	42	29	42	19	42	20	20	13
Average	1	78	90	74	90	83	83	87	83	85	89	83	92	76	84	77	77	74
	2	61	81	55	81	68	68	75	68	72	79	68	84	58	71	59	59	55
	3	48	73	41	73	56	56	65	56	61	71	56	77	44	59	45	45	41
	4	37	65	30	65	46	46	56	46	52	63	46	71	34	50	35	35	30
	5	29	59	23	59	38	38	49	38	44	56	38	65	26	42	27	27	23

Table 6.3 (Cont.)

155mm Crew Member

		Task No.													
	Day	35	36	37	38	39	40	41	42	43	44	45	46	47	48
Low	1	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	2	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	3	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	4	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	5	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Medium	1	100	100	100	100	100	85	100	92	85	100	100	100	92	78
	2	100	100	100	100	100	73	100	84	73	100	100	100	84	61
	3	100	100	100	100	100	62	100	78	62	100	100	100	78	48
	4	100	100	100	100	100	53	100	71	53	100	100	100	71	37
	5	100	100	100	100	100	45	100	65	45	100	100	100	65	29
Heavy	1	100	100	100	100	100	85	92	92	85	100	92	100	92	78
	2	100	100	100	100	100	73	84	84	73	100	84	100	84	61
	3	100	100	100	100	100	62	78	78	62	100	78	100	78	48
	4	100	100	100	100	100	53	71	71	53	100	71	100	71	37
	5	100	100	100	100	100	45	65	65	45	100	65	100	65	29
Average	1	100	100	100	100	100	90	97	94	90	100	97	100	94	85
	2	100	100	100	100	100	81	95	89	81	100	95	100	89	72
	3	100	100	100	100	100	73	92	84	73	100	92	100	84	61
	4	100	100	100	100	100	65	89	80	65	100	89	100	80	52
	5	100	100	100	100	100	59	87	75	59	100	87	100	75	44

Here, as for other types of units, the variability of effectiveness degradation across tasks and level of demand is noted. While some tasks are projected to be degraded only nominally over five days (120 hours) of continuous operations, others are forecast to be very quickly degraded to unacceptable levels. Examples of tasks degraded only nominally include Task No. 35 "laying communications wire to FDC," Task No. 38 "emplacing/recovering aiming posts," and Task No. 44 "fuzing the projectile." Any one of the three CMs can perform these tasks. Examples of tasks projected to degrade to an unacceptable level of performance include Task No. 9 "laying the weapon," and Task No. 16 "determining piece to crest range." These perceptually and cognitively loaded tasks are normally performed by the How SC.

Table 6.4 summarizes the impacts of the debilitating factors on the critical abilities of 155mm Artillery personnel relevant to the performance of their critical tasks. The table heading shows the abilities (see taxonomy in Chapter I) needed for task performance and the debilitating factors (see Chapter I) impacting on these abilities. The body of the table shows the impact. That is, the absence of an entry may be due to the fact that: (a) the task in question is not critical with the given level of demand, (b) the ability in question is not critical for the given task, or (c) the ability in question is not depressed in this task at the given level of demand. Where there is an entry on the table "L" denotes a significant (greater than 20%) depression of the ability with "Low" demand, "M" denotes the same for "Medium" demand, and "H" for "Heavy" demand.

As well as a descriptive summary of adversely affected critical abilities in critical tasks Table 6.4 serves as a cross index. The following information can be obtained from the cross index:

a. critical tasks performed by various duty positions

b. source(s) of adverse impacts on critical abilities

c. adversely affected (depressed) critical abilities in critical tasks

d. adversely affected tasks at each demand level

e. combinations of the above

Table 6.4

Artillery: Summary of Significant Depressions of Critical Abilities

TASK NO.	FATIGUE						DIURNAL RHYTHM		LIGHT LEVEL				STRESS			
	V	H	NF	R	PS	O	NF	R	V	H	DP	O	M	R	PS	C
1									LMH							H
2			MH			MH	LMH		MH			MH	H			
3						MH						MH				H
4			LMH			MH	MH		H			MH	MH	MH		MH
5									H					MH		
6			H	MH									H	H		
7									H							
8									MH					MH		
9	MH		MH			MH	MH		MH			LMH				
10				H		MH			LMH			LMH		MH		
11	MH						H		LMH							
12														H		
13																H
14																H
15			LMH				LMH		LMH							MH
16	MH		LMH	MH			LMH		MH			MH				
17									MH			H		MH		MH
18	MH		MH				MH		LMH							
19			MH						MH							
20	MH		MH			MH			LMH			MH				
21	MH		MH													
22			LMH				MH		MH							
23			LMH				MH		MH							
24			LMH				MH									
25	MH								LMH			MH				
26	MH								MH			MH				
27	MH								MH							
28	MH								LMH			MH				
29	H								MH							
30	MH		MH				LMH		LMH							
31						LMH						LMH				
32						MH			LMH			LMH	MH			
33						MH			LMH			LMH	MH			
34			MH			MH	MH					LMH	MH			
35																
36																
37																
38																
39																
40		MH														MH
41									H							
42									MH							
43									MH						MH	
44																
45									H							
46																
47									MH							
48				MH									MH	MH		

Digest of Critical Task and Their Performance

Succeeding portions of this chapter present a detailed summary of how the conditions associated with continuous operations are anticipated to affect the performance of each of the 48 critical tasks of the 155mm SP Battery personnel. An example of one deviation of task criticality is fully described in an earlier report, entitled, Background Data, Vol. III Human Performance in Continuous Operations Guidelines. Here the performance of each critical task is evaluated in terms of the abilities required for task performance. For example, the Battery Executive Officer's Task No. 1 "laying the Battery when it occupies a firing position," requires Vision, Memory, Orientation and Numerical Facility. The critical abilities are affected by Fatigue, Diurnal Rhythm, Darkness, and Stress.

The relationships among critical abilities and the stressors of continuous operations are presented in Chapter III on the Mechanized Infantry. The various discussions of the effects of stressors on performance presented in Chapter III apply equally to the Artillery.

The task digests which follow provide a compendium of information pertaining to each of the identified critical tasks. Each digest provides the basic identifying information: Task No., the Duty Position which normally carries out this task, and the task title. Next, the critical abilities required for task performance are listed together with the adverse debilitating factors impacting upon and depressing the abilities. Also, listed are Task Nos. under which impacts of debilitating factors on abilities are discussed. These Task Nos. refer to the tasks of the Mechanized Infantry (see Chapter III).

Table 6.5

Artillery: Index of Discussions of Effects of Debilitating Factors on Critical Abilities

Debilitating Factor	Critical Ability	Discussed Under Mechanized Infantry Task No. (Ch. III)
Fatigue	Vision	1, 30, 33
	Hearing	19, 33
	Numerical Facility	57, 66, 68
	Reasoning	57, 66, 68, 74
	Perceptual Speed	29, 30, 57
	Orientation	7, 29, 33
Diurnal Rhythm	Numerical Facility	11, 57, 61
	Reasoning	11, 57, 61
Light Level	Vision	9, 26, 44, 72
	Hearing	22, 33
	Dynamic Precision	18, 20
	Orientation	7
Stress	Memory	56, 69
	Reasoning	45, 53, 54, 74
	Perceptual Speed	2, 6
	Communication	48

NOTES: 1. Task Nos. in body of table refer to task digests appearing in Chapter III.

2. Discussion in task digests are relevant to Armor, Artillery and FIST where common abilities are required.

CRITICAL TASK 1

Position: Battery Executive Officer

Task: Supervise Battery When it Occupies a Firing Position

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Communication	Stress	48

CRITICAL TASK 2

Position: Battery Executive Officer

Task: Lay the Battery When it Occupies a Firing Position

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69

CRITICAL TASK 3

Position: Battery Executive Officer

Task: Measure and Report Directions

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 4

Position: Battery Executive Officer

Task: Control Fires of the Battery

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69
Reasoning	Stress	45, 53, 54, 74
Communication	Stress	48

CRITICAL TASK 5

Position: Battery Executive Officer

Task: Insure Sections Store, Segregate and Protect Ammunition

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Reasoning	Stress	45, 53, 54, 74

CRITICAL TASK 6

Position: Battery Executive Officer

Task: Insure Ammunition is Distributed in Accordance with Anticipated Needs of FDC

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Reasoning	Fatigue	57, 66, 68, 74
	Stress	45, 53, 54, 74
Memory	Stress	56, 69

CRITICAL TASK 7

Position: Howitzer Section Chief

Task: Insure Weapon is Properly Emplaced

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 8

Position: Howitzer Section Chief

Task: Insure Weapon is Ready for Action

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Reasoning	Stress	45, 53, 54, 74

CRITICAL TASK 9

Position: Howitzer Section Chief

Task: Lay the Weapon

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 10

Position: Howitzer Section Chief

Task: Select Aiming Points for Gunner

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Stress	45, 53, 54, 74
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 11

Position: Howitzer Section Chief

Task: Site to the Crest

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Diurnal Rhythm	11, 57, 61

CRITICAL TASK 12

Position: Howitzer Section Chief

Task: Order When to Boresight

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Stress	45, 53, 54, 74

CRITICAL TASK 13

Position: Howitzer Section Chief

Task: Order Azimuths Marked

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 14

Position: Howitzer Section Chief

Task: Order the Prefire Checks Performed

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Communication	Stress	48

CRITICAL TASK 15

Position: Howitzer Section Chief

Task: Measure and Report Site to the Crest

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Vision	Light Level/Visibility	9, 26, 44, 72
Communication	Stress	48

CRITICAL TASK 10

Position: Howitzer Section Chief

Task: Determine Piece to Crest Range

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Light Level/Visibility	7

CRITICAL TASK 17

Position: Howitzer Section Chief

Task: Supervise Section during Firing

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Stress	45, 53, 54, 74
Vision	Light Level/Visibility	9, 26, 44, 72
Orientation	Light Level/Visibility	7
Communication	Stress	48

CRITICAL TASK 18

Position: Gunner

Task: Lay Cannon on Initial Direction of Fire with Aiming Circle

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61

CRITICAL TASK 19

Position: Gunner

Task: Lay Cannon on Initial Direction of Fire with Compass

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 20

Position: Gunner

Task: Lay Cannon in Initial Direction of Fire with Distant Aiming Point

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 21

Position: Gunner

Task: Lay Cannon on Initial Direction of Fire by Reciprocal Lay of Another Cannon

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
Numerical Facility	Fatigue	57, 66, 68

CRITICAL TASK 22

Position: Gunner

Task: Verify Direction of Fire with Reciprocal Check as Control Piece

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 23

Position: Gunner

Task: Verify Direction of Fire with Reciprocal Check as Adjacent Piece

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 24

Position: Gunner

Task: Verify Direction of Fire with Reciprocal Check Using Lighting Device

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61

CRITICAL TASK 25

Position: Gunner

Task: Boresight the Panoramic Telescope with the MAO Alignment Device

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Orientation	Light Level/Visibility	7

CRITICAL TASK 26

Position: Gunner

Task: Boresight the Panoramic Telescope with a Distant Aiming Point

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Orientation	Light Level/Visibility	7

CRITICAL TASK 27

Position: Gunner

Task: Boresight the Panoramic Telescope with the Collimator

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 28

Position: Gunner

Task: Boresight the Panoramic Telescope Using the Testing Target

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Orientation	Light Level/Visibility	7

CRITICAL TASK 29

Position: Gunner

Task: Set/Lay Cannon for Deflection

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 30

Position: Gunner

Task: Refer the Piece

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Fatigue	1, 30, 33
	Light Level/Visibility	9, 26, 44, 72
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61

CRITICAL TASK 31

Position: Gunner

Task: Orient with a Compass

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7

CRITICAL TASK 32

Position: Gunner

Task: Orient a Map by Terrain Association

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Vision	Light Level/Visibility	9, 26, 44, 72
Memory	Stress	56, 69

CRITICAL TASK 33

Position: Gunner

Task: Determine Present Location by Terrain Association

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	Fatigue	7, 29, 33
	Light Level/ Visibility	7
Vision	Light Level/ Visibility	9, 26, 44, 72
Memory	Stress	56, 69

CRITICAL TASK 34

Position: Gunner

Task: Locate a Point on a Map Using the Military Grid Reference System

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Numerical Facility	Fatigue	57, 66, 68
	Diurnal Rhythm	11, 57, 61
Orientation	Fatigue	7, 29, 33
	Light Level/Visibility	7
Memory	Stress	56, 69

CRITICAL TASK 35

Position: Crew Member

Task: Lay Communication Wire to FDC

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	None	
Orientation	None	
Reasoning	None	
Vision	None	

CRITICAL TASK 36

Position: Crew Member

Task: Connect Wire to Telepost Terminal on Vehicle

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	None	

CRITICAL TASK 37

Position: Crew Member

Task: Emplace/Recover Collimator

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	None	
Reasoning	None	

CRITICAL TASK 38

Position: Crew Member

Task: Emplace/Recover Aiming Posts

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Orientation	None	
Reasoning	None	

CRITICAL TASK 39

Position: Crew Member

Task: Store Ammunition at a Cannon Position

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Perceptual Speed	None	
Numerical Facility	None	

CRITICAL TASK 40

Position: Crew Member

Task: Monitor and Relay Fire Commands

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Hearing	Fatigue	19, 33
Communication	Stress	48

CRITICAL TASK 41

Position: Crew Member

Task: Prepare Ammunition for Firing

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 42

Position: Crew Member

Task: Recognize Ammunition Types by Color Coding

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 43

Position: Crew Member

Task: Identify Fuzes and Fuze Wrenches by Type

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72
Perceptual Speed	Stress	2, 6

CRITICAL TASK 44

Position: Crew Member

Task: Fuze the Projectile

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	None	
Numerical Facility	None	
Perceptual Speed	None	
Vision	None	

CRITICAL TASK 45

Position: Crew Member

Task: Set the Fuze Using the Proper Fuze Setter

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 46

Position: Crew Member

Task: Prepare Propellant Charge

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Memory	None	
Numerical Facility	None	

CRITICAL TASK 47

Position: Crew Member

Task: Set/Lay Cannon for Quadrant with the Range Quadrant

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Vision	Light Level/Visibility	9, 26, 44, 72

CRITICAL TASK 48

Position: Crew Member

Task: Operate M109A1 Howitzer Under Unusual Conditions

REQUIRED ABILITIES

The performance of this task requires abilities which are affected by adverse factors associated with continuous combat operations.

Critical Abilities	Adverse Factor(s)	Discussed with Task No.
Reasoning	Fatigue	57, 66, 68, 74
	Stress	45, 53, 54, 74
Memory	Stress	56, 69

CHAPTER VII

RESTRUCTURING OF RESPONSIBILITIES

The potential of restructured task responsibilities for counteracting performance degradation is explored. Projected effects of task reallocations, task sharing, and redundant (parallel) task performance are presented. Reallocation is found to be least promising and parallel task performance to be most promising.

One of the potential means for counteracting the cumulative and aggregate effects of debilitating factors on a military unit during continuous operations is to consider a restructuring of responsibilities. Such a restructuring does not mean a reorganization of lines of responsibility as specified by TOE. Rather, it refers to a rearrangement--a partial or full reallocation of certain critical task responsibilities so as potentially to improve overall performance effectiveness--perhaps only after extreme performance deterioration has begun. Restructuring can involve any one or all of these possiblities:

1. Interchanging or delegating. A critical task normally performed by an individual in duty position A is shifted to or delegated to another individual in duty position B.
2. Paralleling. All of the component activities of certain critical tasks normally performed by an individual in duty position A alone are also performed by another individual in duty position B.
3. Sharing. Some of the component activities of some critical task that is normally performed by an individual in duty position A alone are shifted or delegated to another individual in duty position B.

Assumption

Before considering the potential benefits of a restructuring of responsibilities, some restrictions must be placed on the realistic alternatives. First, it was assumed that tasks and component task activities will not be reallocated across organizational boundaries. To some extent, these boundaries will be determined by the duty position in question. For example, one FO within a FIST team may exchange tasks with another FO of the same FIST team, but not

with an FO of another FIST team. Similarly, a SL of an infantry platoon may interchange tasks with another SL in the same Platoon. However, the PL might interchange tasks with another PL (of a different Platoon) in the same Company (though not of a different Company), and so forth.

A second assumed restriction was that tasks and component task activities may be reallocated either to a coordinate position or a subordinate position, but not to a supraordinate position. That is, a SL tasks might be shifted to another SL or, for example, to some MTM of his Platoon.

A third assumed set of restrictions on realistic possibilities for task reallocation derives from several considerations. Certain line-of-command responsibilities--especially those related to decision making--cannot be delegated. Certain items of equipment (e.g., a .50 Cal MG) are specifically "vested" in a duty position and have multiple uses. Thus, for example, the G/CTL cannot relinquish use of the .50 cal MG to someone else while still performing other tasks that also require the use of the MG. A given duty position may carry with it some unique knowledge and/or skill with respect to some task. Some tasks may be of a type that involves very rapid processing of incoming information so as to react promptly, or the information must be rapidly related to a complex of other information items which is maintained "within a single head."

Method

All identified critical tasks were reviewed by an experienced military advisor and rated as to their potential for interchanging, paralleling, and for sharing according to the above outline criteria. In arriving at these judgments every effort was made to set aside all other preconceptions about the possibilities of potential reallocations.

Approaches to Estimating Effects of Restructuring

In order to evaluate the effects of any sort of restructuring of task responsibilities, it is necessary to have some effectiveness indicator. Such an indicator exists in the form of the effectiveness index E and the E-scale. An average value of E, ($\bar{E}$), expresses the remaining performance capability or effectiveness of (the incumbent of) the duty position under the worst expected conditions at approximately the forty-eighth hour of continuous operations. To assess the effects (benefits or impairment) of a reallocation, the consequent change in the value of $\bar{E}$ was examined.

Within such an approach, no increase or decrease in the overall amount of work done is involved. The total number of tasks that is expected to be performed by a given (incumbent of) duty position in--say--a 24 hour period remains constant. Only a redistribution of types of tasks is involved. If the redistribution increases the proportion of tasks that are highly vulnerable to

degradation or the sum total of task vulnerability, $\bar{E}$ will decrease; in the reverse redistribution $\bar{E}$ will increase. It is the net shift in task vulnerability that counts.

Task Interchange/Reallocations

Tables 7.1 through 7.4 present the projected changes in performance effectiveness that would occur if selected tasks or groups of tasks were reallocated. The reference value of E that is shown in each case is the average across platoon actions for the indicated duty position. Projected comparison values are also averages across platoon actions.

Mechanized Infantry

Four types of duty positions are considered. They are respectively G/CTL (Tasks 1–17), MTM (Tasks 18 – 32), SL (Tasks 33 – 49), and PL (Tasks 50 – 76). These duty positions, which are synonymous with their task sets, are presented below successively. In each case various realistic reallocation possibilities in seemingly meaningful combinations are examined.

Tank Platoon

Though five types of duty positions were identified, only four entered into consideration here: TK PL (Tasks 1 – 26), TK CDR (Tasks 27 – 41), TK GR (Tasks 42 – 46), TK LDR (Tasks 47 – 58). The Tank Driver is not considered here, because no critical tasks were identified for that duty position. Again, various realistic reallocation possibilities in some seemingly coherent groupings are presented. None were projected for TK GR and TK LDR, because: (a) for both the initial task set is quite small, and (b) values of $\bar{E}$ for the tasks they perform are uniformly high with little chance of improvement.

FIST

Four types of duty positions are considered: FIST Chief (Tasks 1 – 29), FO (Tasks 30 – 56), FS NCO (Tasks 57 and 58), and RTO (Task 59). The paucity of critical tasks for the FS NCO and the RTO must be interpreted in the light of their funtioning as Assistant Chief and Assistant FO respectively. When they function as Chief and FO, their effectiveness will be essentially that shown for these positions.

Artillery

The type of artillery unit under consideration here is a battery, and, more specifically, a 155mm SP gun crew. Four types of duty positions are considered: BTRY XO - Battery Executive Officer (Tasks 1 – 6), How SC - Howitzer Section Chief (Tasks 7 – 17), GR - Gunner (Tasks 18 – 34), and--without detailed distinction--CM - Crew Member (Tasks 35 – 48).

Table 7.1

Mechanized Infantry: Effectiveness (E) with Task Reallocations

	$\bar{E}$
Gunner/Carrier Team Leader	
REFERENCE: Original Task Set (1-17)	.62
Eliminations	
Four Most Vulnerable Tasks (1, 6, 11, 14)	.72
Firing Tasks (1, 3, 14, 16)	.65
Overwatching Tasks (2, 4)	.62
Knowledge of Squad's Location (7)	.62
Detecting Enemy (9)	.63
Disengagement Tasks (13, 15)	.61
All Combinations (1-4, 7, 9, 13-16)	.64
Additions	
Observing Terrain (33)	.63
Preparing Range Cards (36)	.61
Establishing Routes to Subsequent Position (37)	.62
Supervising Obstacle/Camouflage Construction (38)	.64
Adjusting Firing as Necessary (39)	.57
Making New Range Cards as Needed (42)	.61
ALL (33, 36-39, 42)	.57
Carrier/Maneuver Team Member	
REFERENCE: Original Task Set (18-32)	.74
Eliminations	
Three Most Vulnerable Tasks (19, 20, 25)	.79
Weapons Condition Task (18)	.74
Target Acquisition Task (19)	.76
Firing Tasks (20, 26, 30, 32)	.76
Orienting/Locating/Moving-Spatial Reference (21-25, 29, 31)	.72
ALL-except Task 27	1.00
Additions	
Firing from Bounding Vehicle (1)	.72
Overwatching Bounding Vehicle (2)	.73
Firing to Protect Bounding Vehicle (3)	.74
Overwatching Dismount (4)	.75
Firing CAL 50 MG at Areas (5)	.76
Detecting Enemy Movement (9)	.73
Covering Disengaging Squads (14)	.73
Firing to Protect Regrouping (16)	.74
ALL (1-5, 9, 14, 16)	.72

Table 7.1 (Cont.)

Squad Leader

	$\bar{E}$
REFERENCE: Original Task Set (33-49)	.44
Eliminations	
Three Most Vulnerable Tasks (39, 41, 44)	.59
Observe Terrain/Establish Communications (33, 34)	.41
Additions	
Knowledge of Squad Location (7)	.45
Repositioning to Allow Other SWs to Fire (13)	.45
Maintaining Concealed Disengagement (15)	.46
Conducting Reconnaissance (50)	.45
Checking Accuracy of Terrain Maps (51)	.45
Deciding to Engage Unexpected Fire or Not (53)	.45
Directing Mounted Defense (54)	.43
Communicating with OPs (55)	.46
Requesting Possible Support Fire Requirements (56)	.43
Selecting Positions (57)	.44
Communicating with Company, etc. (65)	.46
Directing Protective Fire for Move to Assembly (71)	.45
Calling Indirect Fire Required for Disengagement (75)	.46
ALL (7, 13, 15, 50, 51, 53-55, 57, 65, 71, 75)	

Platoon Leader

REFERENCE: Original Task Set (50-76)	.61
Eliminations	
Five Most Vulnerable Tasks (54, 56, 57, 68, 69)	.71
Checking Accuracy of Terrain Maps (51)	.61
Communication Tasks (55, 62, 65)	.58
Fire Direction/Support Tasks (56, 71, 75)	.62
ALL (51, 55, 56, 62, 71, 75)	.67
Additions	
None	

Table 7.2

Armor: Effectiveness (E) with Task Deletions

	E
Tank Platoon Leader	
REFERENCE: Original Task Set (1-26)	.74
Eliminations	
Two Most Vulnerable Tasks (14, 24)	.78
Fire Planning & Control Tasks (1, 2, 12-21, 24)	.75
Locating/Positioning Tasks (3-8, 22)	.77
Command Supervision Tasks (10, 11, 23, 25, 26)	.72
Additions	
None	
Tank Commander	
REFERENCE: Original Task Set (27-41)	.83
Eliminations	
Two Most Vulnerable Tasks (35, 39)	.87
Coordinating & Reporting Tasks (27, 28, 31, 32, 41)	.79
Fire Planning & Control Tasks (29, 30, 35, 36, 37)	.82
Fire MG Task (38)	.82
Additions	
None	
Tank Gunner	
REFERENCE: Original Task Set (42-46)	.93
Eliminations	
Tank Loader	
Original Task Set (47-58)	.99

Table 7.3

FIST: Effectiveness (E) with Task Reallocation

	$\bar{E}$
FIST Chief	
REFERENCE: Original Task Set (1-29)	.58
Eliminations	
Four Most Vulnerable Tasks (10, 14, 20, 26)	.68
Orienting/Locating Tasks (5, 8, 9)	.57
Coordination, etc. (1-4, 27, 29)	.52
Command & Control (6, 11, 13, 17, 18, 19, 28)	.53
Adjust Fire Tasks (10, 12, 14-16, 20-26)	.79
Additions	
None	
Forward Observer	
REFERENCE: Original Task Set (30-56)	.54
Eliminations	
Four Most Vulnerable Tasks (45, 48, 50, 54)	.63
Coordination/Communications Tasks (30-34, 56)	.47
Orienting & Locating Tasks (35, 37-41)	.53
Evaluation Tasks (42, 44, 55)	.53
Adjust Fires Tasks (43, 45-54)	.67
Additions	
None	
Fire Support NCO	
REFERENCE: Original Task Set (57, 58)	.95
Eliminations	
None	
Additions	
Adjust Fire Tasks (10, 12, 14-16, 20-26)	.43
Coordination, etc. (1-4, 27, 29)	.88
Radio Telephone Operator	
REFERENCE: Original Task Set (59)	.89
Eliminations	
None	
Additions	
Coordination/Communications Tasks (30-34, 56)	.87
Evaluation Tasks (42, 44, 55)	.68
Adjust Fires Tasks (43, 45, 46-54)	.41

Table 7.4

Artillery: Effectiveness (E) with Task Reallocations

	$\bar{E}$
Battery Executive Officer	
REFERENCE: Original Task Set (1-6)	.63
Eliminations	
Most Vulnerable Task (4)	.75
Battery Emplacement Tasks (1-3)	.56
All Combinations (1-4)	.81
Additions	
None	
Howitzer Section Chief	
REFERENCE: Original Task Set (7-17)	.71
Eliminations	
Two Most Vulnerable Tasks (9, 16)	.76
Laying, etc., Tasks (9-13)	.71
Safety (14-16)	.73
All Combinations (9-16)	.78
Additions	
Battery Emplacement Tasks (1-3)	.71
Orienting/Locating Tasks (31-34)	.68
Laying/Referring Tasks (18-21, 30)	.70
ALL (1, 2, 3, 18-21, 30-34)	.68
155mm Gunner	
REFERENCE: Original Task Set (18-34)	.68
Eliminations	
Five Most Vulnerable Tasks (20, 30, 32-34)	.66
Laying/Referring Tasks (18, 21, 29, 30)	.67
Verifying Tasks (22-24)	.67
Boresighting Tasks (25-28)	.66
Orienting Tasks (31-34)	.70
Additions	
Laying, Etc. Tasks (9-13, 47)	.69
Safety (14-16)	.68
ALL (9-16, 47)	.69

Table 7.4 (Cont.)

155mm Crew Member

	$\bar{E}$
REFERENCE: Original Task Set (35-48)	.93
Eliminations	
Three Most Vulnerable Tasks (40, 43, 48)	.98
Use Range Quadrant (47)	.93
Ammunition Preparation (41-46)	.92
Additions	
Laying/Referring Tasks (18-21, 29, 30)	.85
Verifying Tasks (22-24)	.88
Boresighting Tasks (25-28)	.87
Orienting Tasks (31-34)	.84
ALL (18-34)	.78

Discussion

The preceding results suggest that a redistribution of (critical) tasks or a partial reconstitution of duty positions does not provide a particularly effective management option for counteracting the debilitative effects of continuous operations. The improvements to be obtained in this way, if any, appear quite small.

With respect to Mechanized Infantry, the changes in the overall $\overline{E}$ for each duty position that can be induced tend to be in the range of $\pm$ 5. This holds within the strict interpretation of realistic reallocation. For example, the value of $\overline{E}$ for MTMs could be raised as much as 26, but only by confining activities to a single critical task. Similarly, in the cases of the SL and PL, substantial improvements would require extravagant task reallocations.

This situation is even more pronounced with respect to Armor. Here, the physical restrictions imposed by space and location in the tank already reduce the number of even remotely possible task reallocations. The calculated effects for the remaining possibilities were trivial.

In the case of FIST a pronounced improvement ($\Delta \overline{E}$ = +21) was indicated, if the FIST Chief were to be relieved of all obligations to adjust fires. A large improvement ($\Delta \overline{E}$ = +13) would occur, also, if the FO were relieved of these responsibilities. On the other hand, if performance of these tasks was allocated to the FS NCO or RTO, very substantial decrements were calculated to occur ($\Delta \overline{E}$ = -52 and $\Delta \overline{E}$ = -48 respectively). Accordingly, there appears to be no net advantage in the potential reshuffle.

With respect to the 155mm gun crew, it is again doubtful whether any significant advange might be gained through task reallocation. While elimination of the fire control responsibilities from the BTRY XO duties was indicated to raise his effectiveness ($\Delta \overline{E}$ = +12), these responsibilities are also at the core of the XO's function.

Despite these unpromising projections, task reallocations should be considered when rested individuals are potentially available for assignment.

Paralleling Task Performance

Table 7.5 below presents the anticipated changes in $\overline{E}$ consequent to paralleling the task performance. Task numbers, as before, correspond to critical task titles listed in Tables 1.2 - 1.5. The first column in each case lists the original value of $\overline{E}$ (average across the three types of platoon actions), the second column lists the expected value ($\overline{E}_p^*$), and the last column (Δ +) indicates the amount of incremental change in $\overline{E}$ as a consequence of the paralleling.

Table 7.5

Parallel Task Performance Effects

1. Mechanized Infantry

	Task No.	$\bar{E}$	$\bar{E}_p^*$	Δ +		Task No.	$\bar{E}$	$\bar{E}_p^*$	Δ +
G/CTL	1	52	77	25	SL	33	72	92	20
	2	56	81	25		34	85	98	13
	3	76	94	18		35	76	94	18
	4	85	98	13		36	45	70	25
	7	64	87	23		37	49	74	25
	9	53	78	25		38	90	99	9
	13	62	86	24		39	13	24	11
	14	38	62	24		42	46	71	25
	15	81	96	15		–	–	–	–
	16	67	89	22	PL	50	59	83	24
	–	–	–	–		51	73	93	20
MTM	18	77	95	18		53	68	90	22
	19	55	80	25		54	28	48	20
	20	61	85	24		55	95	100	5
	21	68	90	22		56	31	52	21
	22	77	95	18		57	45	70	25
	23	90	99	9		62	89	99	10
	24	77	95	18		65	94	100	6
	25	55	80	25		71	69	90	21
	26	73	93	20		75	85	98	13
	27	100	100	0		–	–	–	–
	28	82	97	15		–	–	–	–
	29	81	96	15		–	–	–	–
	30	69	90	21		–	–	–	–
	31	90	99	9		–	–	–	–
	32	72	92	20		–	–	–	–

2. Tank Platoon

TK PL	3	60	84	24	–	–	–	–
	4	64	87	23	–	–	–	–
	5	68	90	22	–	–	–	–
	6	60	84	24	–	–	–	–
	7	68	90	22	–	–	–	–
	12	80	96	16	–	–	–	–
	13	80	96	16	–	–	–	–
	14	46	71	25	–	–	–	–
	18	68	90	22	–	–	–	–
	24	37	60	23	–	–	–	–

Table 7.5 (Cont.)

	Task No.	$\bar{E}$	$\bar{E}_p^*$	Δ+	Task No.	$\bar{E}$	$\bar{E}_p^*$	Δ+
TK CDR	30	84	97	13	-	-	-	-
	33	80	96	16	-	-	-	-
	35	61	85	24	-	-	-	-
	40	65	88	23	-	-	-	-
						-	-	
TK GR	42	89	99	10	-	-	-	-
						-	-	
TK LDR	47	100	100	0	-	-	-	-
	48	100	100	0	-	-	-	-
	49	100	100	0	-	-	-	-
	50	100	100	0	-	-	-	-
	57	95	100	5	-	-	-	-
	58	100	100	0	-	-	-	-
				3. FIST				
CHIEF	5	71	92	21	46	69	90	21
	6	89	99	10	47	36	59	23
	8	65	88	23	48	23	41	18
	9	75	94	19	49	53	78	25
	10	25	44	19	50	29	50	21
	12	73	93	20	51	60	84	24
	14	25	44	19	52	76	94	18
	15	47	72	25	53	37	60	23
	16	41	65	24	54	10	19	9
	20	23	41	18	55	82	97	15
	21	69	90	21	56	84	97	13
	22	31	52	21	-	-	-	-
	23	60	84	24	-	-	-	-
	24	76	94	18	-	-	-	-
	25	37	60	23	-	-	-	-
	26	10	19	9	-	-	-	-
	27	82	97	15	-	-	-	-
	29	85	98	13	-	-	-	-
FO	35	48	73	25	-	-	-	-
	37	65	88	23	-	-	-	-
	38	58	82	24	-	-	-	-
	39	44	69	25	-	-	-	-
	40	61	85	24	-	-	-	-
	41	61	85	24	-	-	-	-
	42	37	60	23	-	-	-	-
	43	73	93	20	-	-	-	-
	45	25	44	19	-	-	-	-

Table 7.5 (Cont.)

4. 155mm Artillery Battery

	Task No.	$\bar{E}$	$\bar{E}_p^*$	$\Delta+$		Task No.	$\bar{E}$	$\bar{E}_p^*$	$\Delta+$
XO	1	80	96	16	CM	37	100	100	0
	2	61	85	24		38	100	100	0
	3	76	94	18		39	100	100	0
	5	85	98	13		40	81	96	15
	6	76	94	18		41	95	100	5
						42	89	99	10
HOW SC	9	49	74	25		43	81	96	15
	10	56	81	25		44	100	100	0
	11	72	92	20		45	95	100	5
	15	56	81	25		46	100	100	0
	16	52	77	25		47	89	99	10
						48	72	92	20
GR	18	61	85	24		-	-	-	-
	19	81	96	15		-	-	-	-
	20	55	80	25		-	-	-	-
	21	81	96	15		-	-	-	-
	22	68	90	22		-	-	-	-
	23	68	90	22		-	-	-	-
	24	75	94	19		-	-	-	-
	25	68	90	22		-	-	-	-
	26	72	92	20		-	-	-	-
	27	79	96	17		-	-	-	-
	28	68	90	22		-	-	-	-
	29	84	97	13		-	-	-	-
	30	58	82	24		-	-	-	-
	31	71	92	21		-	-	-	-
	32	59	83	24		-	-	-	-
	33	59	83	24		-	-	-	-
	34	55	80	25		-	-	-	-

The Mechanized Infantry duty positions considered were G/CTL, MTM, SL, and PL. For Armor, or the TK PLT, the duty positions were TK PL, TK CDR, TK GR, and TK LDR. For FIST, there was only the FIST Chief and FO. For previously stated reasons, the FS NCO and RTO were not considered. Finally, for Artillery the duty positions under consideration were BTRY XO, How SC, 155mm GR, and 155mm CM.

Discussion

Not unexpectedly, the predicted benefits of paralleling task performance proved to be substandtially greater than those for task reallocation. The meaning of $\overline{E}$ or $\overline{E}^*$ in this case is the effectiveness with which the task will be performed. Predicted results agree with the common sense inference that two people performing the same task, even when exhausted, are more likely to bring it to a satisfactory conclusion than a single person.

Predicted changes, if any, are uniformly positive (incremental). In some cases, the increase is as high as 25 or one quarter of the extent of the E-scale. The cases in which no improvement is predicted are uniformly those in which there is no room for improvement, i.e., baseline performance is 100. The maximum of incremental performance is obtained over the mid-range of deterioration. With very extreme deterioration the expected improvement appears slight. The practical feasibility of committing two persons to a single task, of course, requires a management evaluation.

Sharing Task Performance

Whereas in parallel task performance the given task is performed independently by two people (performance duplication), in task sharing some steps are carried out by either of two people. Lacking specific information about who does what, it can be assumed that for any component step of performance there is a 50/50 chance of rectification or compensation for performance inadequacy.

Table 7.6 presents the projected effects of shared task performance in the same tasks considered previously. As before, the first column following the task number lists the original value of $\overline{E}$, the second column the expected value ($E\overline{s}^*$), and the last column indicates the amount of incremental change ($\Delta+$) in $\overline{E}$ as a consequence of shared performance.

Table 7.6 indicates that sharing the execution of a task also provides considerable benefit. However, the benefit is less than that for performing the task in parallel. As before, the improvement tended to be most substantial over the mid-range of deterioration. Ceiling effects (i.e., little room for improvement) restricted benefits at the upper extreme. At the lower extreme, these benefits may be too insubstantial for practical purposes. Hence, paralleling rather than sharing performance may be advisable.

Table 7.6

Shared Tasks Performance Effects

1. Mechanized Infantry

	Task No.	$\bar{E}$	$\bar{E}_s^*$	Δ+		Task No.	$\bar{E}$	$\bar{E}_s^*$	Δ+
G/CTL	1	52	67	15	SL	33	72	85	13
	2	56	71	15		34	85	94	9
	3	76	88	12		35	76	88	12
	4	85	94	9		36	45	59	14
	7	64	78	14		37	49	64	15
	9	53	68	15		38	90	97	7
	13	62	77	15		39	13	19	6
	14	38	51	13		42	46	60	14
	15	81	92	11		–	–	–	–
	16	67	81	14	PL	50	59	74	15
						51	73	86	13
MTM	18	77	89	12		53	68	82	14
	19	55	70	15		54	28	39	11
	20	61	76	15		55	95	99	4
	21	68	82	14		56	31	43	12
	22	77	89	12		57	45	59	14
	23	90	97	7		62	89	96	7
	24	77	89	14		65	94	99	5
	25	55	70	15		71	69	83	14
	26	73	86	13		75	85	94	9
	27	100	100	0		–	–	–	–
	28	82	92	10		–	–	–	–
	29	81	92	11		–	–	–	–
	30	69	83	14		–	–	–	–
	31	90	97	7		–	–	–	–
	32	72	85	13		–	–	–	–

2. Tank Platoon

TK PL	3	60	75	15	TK CDR	30	84	94	10
	4	64	78	14		33	80	91	11
	5	68	82	14		35	61	76	15
	6	60	75	15		40	65	79	14
	7	68	82	14		–	–	–	–
	12	80	91	11	TK GR	42	89	96	7
	13	80	91	11		–	–	–	–
	14	46	60	14	TK CDR	47	100	100	0
	18	68	82	14		48	100	100	0
	24	37	50	13		49	100	100	0
	–	–	–	–		50	100	100	0
	–	–	–	–		57	95	99	4
	–	–	–	–		58	100	100	0

Table 7.6 (Cont.)

3. FIST

	Task No.	$\bar{E}$	$\bar{E}_s^*$	Δ+		Task No.	$\bar{E}$	$\bar{E}_s^*$	Δ+
CHIEF	5	71	84	13		41	61	76	15
	6	89	96	7		42	37	50	13
	8	65	79	14		43	73	86	13
	9	75	88	13		45	25	35	10
	10	25	35	10		46	69	83	14
	12	73	86	13		47	36	49	13
	14	25	35	10		48	23	32	9
	15	47	61	14		49	53	68	15
	16	41	55	14		50	29	40	11
	20	23	32	9		51	60	75	15
	21	69	83	14		52	76	88	12
	22	31	43	12		53	37	50	13
	23	60	75	15		54	10	15	5
	24	76	88	12		55	82	92	10
	25	37	50	13		56	84	94	10
	26	10	15	5		-	-	-	-
	27	82	92	10		-	-	-	-
	29	85	94	9		-	-	-	-
FO	35	48	63	15		-	-	-	-
	37	65	79	14		-	-	-	-
	38	58	73	15		-	-	-	-
	39	44	58	14		-	-	-	-
	40	61	76	15		-	-	-	-

4. 155mm Artillery Battery

XO	1	80	91	11		30	58	73	15
	2	61	76	15		31	71	84	13
	3	76	88	12		32	59	74	15
	5	85	94	9		33	59	74	15
	6	76	88	12		34	55	70	15
HOW SC	9	49	64	15	CM	37	100	100	0
	10	56	71	15		38	100	100	0
	11	72	85	13		39	100	100	0
	15	56	71	15		40	81	92	11
	16	52	67	15		41	95	99	4
						42	89	96	7
GR	18	61	76	15		43	81	92	11
	19	81	92	11		44	100	100	0
	20	55	70	15		45	95	99	4
	21	81	92	11		46	100	100	0
	22	68	82	14		47	89	96	7
	23	68	82	14		48	72	85	13
	24	75	88	13		-	-	-	-
	25	68	82	14		-	-	-	-
	26	72	85	13		-	-	-	-
	27	79	90	11		-	-	-	-
	28	68	82	14		-	-	-	-
	29	84	94	10		-	-	-	-

Summary

When the three possibilities of restructuring duty responsibilities were compared, it was quite evident that paralleling of task performance should provide the most effective method of restructuring. The improvements, which are thus attainable, demand that a price (duplication of effort) be paid. This price is attenuated, as are benefits, when performance is merely shared by two persons. Redistribution of responsibilities (task reallocation) seemed to offer the least promise so long as all duty positions in question are equally debilitated. If some duty positions were manned with rested (undeteriorated) personnel a more substantial benefit would be noted. However, the relative magnitudes of improvements obtainable via the three approaches would remain as before.

CHAPTER VIII

TRAINING OPERATIONS AND CONDITIONS

This chapter deals with training operations, conditions and patterns designed to create a performance capability that is maximally resistant to degradation. Five general training principles particularly applicable to this purpose are outlined. Specific recommendations are listed and related to specific critical tasks. Cross training considerations and recommended priorities are suggested.

Training is perhaps the most effective of all means for counteracting prospective degradation of performance resulting from continuous operations. Of course, the realization of the counteractive potential is dependent on a preparatory period in advance of actual combat operations. Training is an anticipating means for coping with performance degradation rather than a concurrent management technique. As well as requiring time, the realization of full training benefits also requires proper training operations carried out in the proper surrounding conditions.

Overtraining

Overtraining refers to the process of practicing the performance of a task for beyond its basic mastery until its execution becomes:

(1) rapid

(2) highly reliable

(3) automatic.

The "over" in overtraining does not imply excessive or unnecessary training. It implies practice beyond the point of initial mastery.

To appreciate the importance of overtraining or continued practice, consider the task of operating an automobile. In starting the car, the novice must successively think about depressing the clutch, placing the gear shift lever into neutral, depressing the gas pedal (and how far), engaging the starter, and so forth. By contrast the experienced driver performs all of these operations smoothly in an integral pattern, and without any clear or specific awareness of each. Especially when tired, tense, or distracted, the novice will forget one or the other component operation, or he will perform them in the wrong order.

Overtraining leads to a maximum of efficiency in task performance, reliable execution, and automaticity of performance. The achievement of high automaticity of performance strongly counteracts the degradation from debilitating factors (e.g., fatigue, stress, etc.) in the surrounding situation.

Patterns of Practice

Mere repetition of task performance is not, in itself, a guarantee that the desired benefits of overtraining will be obtained. Task performance must be practiced under all conditions under which the task may have to be performed. For example, until relatively recent times, rifle marksmanship training took place on a rifle range. These conditions differ markedly from those encountered in combat. Observed performance under combat conditions fell far short of levels observed on the rifle range. Therefore, changes in marksmanship training procedures were instituted.

Adequate performance by individual soldiers in isolation does not guarantee adequate performance of a team assembled from these same soldiers. Similarly, no amount of practice of a task in isolation assures its smooth performance in the context of preceding, parallel, and succeeding tasks.

Some degree of forgetting will affect even a task mastered to a high degree of automaticity. For example, many sports and musical instruments demand continual practice. At the same time, efficient practice should concentrate on those tasks or aspects of task performance that have not yet been learned or learned sufficiently.

In summary:

- Practice critical tasks under all conditions under which they may have to be performed.
- Practice critical tasks in all of their contexts.
- Devote appropriate proportions of available time (or different frequencies) to the practice of more and less well mastered tasks and/or combinations of tasks.

Some Useful Training Principles and Techniques

In conducting training operations intended to forestall or attenuate performance degradation in continuous combat operations, the points outlined below should be kept in mind. These recommendations do not constitute an exhaustive list of training principles and techniques. Rather, they constituted a listing of those considered to be most relevant for training to counteract the debilitation accompanying continuous operations.

(1) Practice In All Degraded Visibility Conditions

The amount and the organization (patterns) of visual information available to the trainee will differ with differing visual conditions. Visibility conditions include not only light levels (darkness, twilight), but also fog, smoke, rain, snow, glare, extreme contrasts, and the like. There is less information obtained about a given terrain, for example, during a dark night than during a sunny day. Not only can fewer landmarks be detected, but these landmarks themselves will look different and the overall visual pattern (i.e., which landmark is where and in relation to what) will be different. To maintain good orientations, trainees must become highly proficient at relating maximum (clear daylight) visual information to reduced visual information and vice versa.

The effect of bright lights such as, flares, searchlights, weapons' flashes, etc. on dark adapted vision also requires consideration. Training should aim for two objectives:

(1) avoiding flash exposure or minimizing it

(2) coping with the transient effects of flash on vision.

(2) Gradually Increase Severity Of Conditions And Difficulty Of Tasks

Before basic mastery of a critical task has been achieved, the trainee should be exposed to none, or as few as possible of the adverse, debilitating factors. After that basic mastery has been achieved, these factors should be gradually introduced into task practice.

Just as there should be a gradual, progressive introduction of debilitating factors so should there be a gradual, progressive increase in the difficulty (i.e., complexity, precision, rate of situation change, etc.) of each critical combat task. For example, Mechanized Infantry Task No. 6 requires the G/CTL to coordinate his fire with that of other vehicles and dismounted elements. The "easy" version of this task might involve one or two coordinating elements, only one or two targets, and these targets might be unmistakable enemy targets. The "difficult" version might involve five coordinating elements, 10 target possibilities, a 50/50 mix of friendly/enemy, rapid changes, and so forth.

(3) Maximize Practice Of Vulnerable Tasks

Other things equal, the greater the frequency with which a task is practiced, or the greater the cumulative amount of time devoted to practice, the more thoroughly it will be learned, i.e., the greater the automaticity, reliability, and rapidity of its performance. The practical question is how a lot of practice in vulnerable (subject to extreme degradation) tasks can be achieved under the worst expected conditions. For example, Task No. 39 "Adjust fire as necessary" of an infantry SL is of this type. In the

worst case, this task is practiced after the trainee has suffered extreme sleep loss, disrupted diurnal rhythms, is performing in darkness, and under stress (noise, confusion, etc.)

Training should provide planned opportunities for practice of specific tasks rather than depending on the chance occurrence of conditions in a developing exercise. Once the trainee is in the exhausted, confused, and stressful situation, preplanned repetitive practice can be provided. For the example above (Mechanized Infantry Task No. 39), the SL can be asked to adjust fire again and again, e.g., with different preplanned "enemy" attack patterns. If the actual situation cannot be so manipulated, some degree of simulation may be possible.

④ Simulate Critical Features For Practice

An adequate simulation is easiest when task performance is primarily dependent on reasoning, numerical manipulation, decision making, communication, and similar cognitive (intellectual) efforts. When abstract information (e.g., target locations, types, numbers, etc.) is received over, perhaps, radio telephone, evaluated, a decision reached and communicated (perhaps again via radio telephone), very low fidelity of physical simulation is sufficient. It may even suffice to provide a series of preprinted problems to which a response must be formulated and recorded with pencil. It will be recalled that cognitive aspects of task performance are the most vulnerable ones.

High physical fidelity of simulation is called for only when the task in question is primarily of a sensory- perceptual - motor type. For example, acquiring a target, aiming and firing with a CAL 50 MG call for something very closely resembling a CAL 50 MG in size, configuration mass, dynamics, and so forth. The best simulation will be the CAL 50 MG itself. As for the target, a "cardboard cutout" will do so long as it visually approximates the simulated object. Recall, also, that tasks of this type are very resistant to degradation (though vigilance in detecting randomly appearing targets is not).

⑤ Provide Ample Reinforcement (Reward) During Practice

The technical term "reinforcement" does not refer to a strengthening of performance itself, but to increasing the likelihood that some item of performance will reoccur in proper form on subsequent occasions. Reinforcement, a concept similar to reward, is considered a fundamental requirement for effective learning. For present purposes, reinforcement can be considered in terms of a very few practical possibilities.

Table 8.1

Specific Training Recommendations

Training/Practice Recommendations:	Applies to:			
	Mechanized Infantry Task No.	Armor Task No.	FIST Task No.	Artillery Task No.
Practice task when trainee is in a state of extreme exhaustion from 36+ hours of sleep loss	ALL	ALL	ALL	ALL
Practice trials should be of extended duration so as to induce fatigue due to task activity	1, 3, 16, 20, 26, 28, 30, 32	19, 36, 43, 46	7, 12, 36, 43	18-30
Schedule task practice between 0200-0600	10-13, 35, 36, 39, 41, 42, 44, 51, 53, 54, 60, 66, 71-74	1, 2, 6, 7, 12-14, 16, 18, 22, 24, 35, 39	3, 4, 6, 9, 10, 13-16, 20-26, 28, 34, 38, 40, 41, 44-54	2, 3, 9, 11, 15, 16, 18-34, 45, 47
Provide for some practice in low temperatures (-10°C to +5°C); require moderately prolonged exposure of hands to cold	1, 18, 20, 26, 28, 30, 32	47, 48, 53, 54, 57		15, 16, 18-29, 44, 45
Practice task in full daylight, twilight, darkness, rain, fog, with smoke present, etc.	1-7, 9, 11-16, 19-33, 35-37, 39-44, 47, 49-51, 54, 57, 59-61, 63, 64, 66, 68, 69, 71-74, 76	3-7, 15, 16, 18-21, 23, 24, 33, 35, 36, 38, 40, 42, 43	5, 7-16, 20-27, 35-55	2, 3, 9-11, 15, 16, 18-34
Provide a high frequency of target possibilities of which a high percentage are actual targets	3, 6, 14, 16, 19, 26, 30, 32, 41, 44, 46, 61, 71-73	15, 18, 20, 21, 33, 38, 42, 43	11, 39, 42	
Present a constantly changing mix of friendly/enemy target possibilities with constantly changing ratios (at times 7-10 target choices)	1, 3, 6, 9, 14, 16, 19, 20, 26, 30, 32, 39, 41, 44, 46, 61, 71-73	15, 18, 20, 21, 33, 38, 42, 43	11, 39, 42	
Provide for varying contrast ratios of targets/backgrounds	1-4, 6, 9, 16, 19, 26, 28, 30, 32, 33, 44, 54, 71, 73	15, 19, 33, 34, 36, 38, 42, 43	10-12, 14, 20, 22, 23, 25-27, 36, 39, 43, 45, 48-50, 51, 53,55	

Table 8.1 (Cont.)

Training/Practice Recommendations:	Applies to:			
	Mechanized Infantry Task No.	Armor Task No.	FIST Task No.	Artillery Task No.
Provide for firing from moving vehicle at moving target(s)	1, 6, 16, 20, 26, 28, 30, 32	19, 21, 36, 38, 43, 46	7, 36	
Assure that some target movements are over very short distances	2, 4, 9, 19, 33	15, 33, 42, 43	11, 39, 42	
Require trainee to use only one eye as well as both eyes	1-4, 9, 14, 16, 19, 20, 26, 30, 32, 33	21, 38, 43, 46		
Arrange exposure to sudden bright light so as to induce flash blindness	1-4, 6, 14, 16, 19, 20, 26, 28, 30, 32, 33	15, 19, 21, 33, 36, 38, 42, 43, 46	7, 36	
Require landmarks established in daylight recon to be used at night and vice versa	7, 11, 12, 24, 29, 31, 35, 36, 37, 40, 42, 43, 47, 49-51, 57, 60, 69, 76	1-7, 23, 24, 35	3-5, 8-10, 12, 14-16, 20-26, 33-35, 37, 38, 45-54	2, 3, 11
Induce stress by any one or all of these means: 1. loud unpredictable noises 2. supervisory pressure 3. deliberate distractions 4. requirements for rapid task execution	1-4, 6-10, 12-14, 22, 24, 25, 35, 39-41, 43-49, 52-76	1-8, 10, 16, 18, 22-28, 30, 32, 35, 39, 41	2-6, 10-28, 32-35, 42-55, 58	1, 4, 8, 17, 18-24, 31-34, 42-48
Maximize the quantity of numerical data to be processed in this task	6, 11, 36, 42, 60, 63, 69	1, 2, 12-14	2-4, 26, 32-34, 54	41, 45, 46 48
Progressively increase: 1. number of missions 2. number of changes 3. types of changes 4. countermands		1, 2	4, 17, 26, 27, 32-34, 54, 55	4, 17, 40-47

Table 8.1 (Cont.)

Training/Practice Recommendations:	Applies to:			
	Mechanized Infantry Task No.	Armor Task No.	FIST Task No.	Artillery Task No.
Progressively introduce incomplete and inaccurate data that are at variance (incompatible with) prior or other concurrent information; also, make corrections to given data	11, 24, 35, 50, 51, 60	12-15, 18, 32, 33, 42, 43	2-4, 11, 17-19, 30-34, 39	4, 17-29, 40
Precede terrain practice with preorientation briefings supported by maps	11, 35, 37, 42, 43, 60, 69, 76	4-7	5, 8, 9, 35, 37, 38	2, 3, 11, 15, 16, 31-34
Protract practice over an extended sequence of locations, and introduce major elements of confusion (shifts in direction, backtracking)	7, 12, 29, 40, 43, 49, 76	23	8, 9, 37, 38	31-34
Progressively increase complexity of map/chart data as their reliability decreases simultaneously	11, 24, 35-37, 50, 51, 60, 69, 75	1-7, 13, 14, 24, 35	2-5, 8-12, 14-16, 20-26, 32-35, 37-43, 45-54	31-34
Provide trainees with some obsolete terrain maps that contain inaccuracies and discrepancies	11, 35-37, 50, 51, 60, 69, 75	1-7, 13, 14, 24, 35	2-5, 8-12, 14-16, 20-26, 32-35, 37-43, 45-54	31-34
Present trainee with rapidly and complexly changing requirements	6, 10, 13, 39-41, 43-47, 53, 54, 57, 63, 64, 71-74	16, 18, 22, 23, 39, 40	2-4, 6, 11, 13, 17-19, 32-34, 42	4, 17, 39, 41, 48
Progressively introduce complex constraints on possible movement patterns	12, 15, 23, 29, 31, 37, 40, 43, 47, 49, 64, 76	5, 23, 40		
Progressively introduce increasingly complex decision factors	10, 53, 66	3-7, 16, 22, 25, 39	5, 13, 19, 28, 35, 44	6

Table 8.1 (Cont.)

Training/Practice Recommendations:	Applies to:			
	Mechanized Infantry Task No.	Armor Task No.	FIST Task No.	Artillery Task No.
Progressively increase: 1. kinds of information sources, and 2. rate and synchrony of message arrival	6, 55, 62, 65, 76	1, 2, 8, 9	1-4, 30-34	40
Provide progressively more complex and ambiguous decision data	6, 10, 41, 43, 44, 47, 49, 53, 54, 61, 63, 64, 66, 68, 70-74, 76	3-7, 11, 16, 22, 25, 37, 39	5, 6, 11, 13, 28, 35, 42, 44	6
Progressively increase the quantity and complexity of target data	6, 39, 44, 46, 56, 61, 63, 71-75	1, 2, 12, 13, 14, 17, 18, 24, 35	6, 10-12, 14-16, 20-26, 42, 43, 45-54	
Increasingly deny requests so as to force search for alternate solutions to problems	52, 56, 62, 75	1, 2, 18	18, 19, 29, 56, 58	
Progressively decrease the time available to react appropriately (e.g., distance and suddenness of target appearance)	1-4, 14, 16, 20, 26, 28, 30, 32, 39, 41, 44, 53, 54, 71-73	15. 20, 21, 33, 37, 38, 42, 43, 46	11, 42	
Progressively reduce the permissible time for task completion	13, 17, 29, 38, 42, 50, 51	8, 10, 11, 25, 26, 29, 34, 41, 45, 47-50, 53-55, 57, 58		ALL
Provide for sufficient noise in communication channel (e.g., radio telephone) to impair communication	6, 8, 48, 55, 56, 58, 62, 65	1, 2, 8, 9 23-28, 32, 41	1-4, 10-12, 14-34, 42, 43, 45-59	22-24, 40
Provide for various combinations of distance and mutual visibility of communicants and vary the noise level	6, 17, 22, 39-41, 43, 44, 46, 47, 49	10		1, 2, 9, 11-15, 17-21, 25-30, 40, 47, 48

Table 8.1 (Cont.)

Training/Practice Recommendations:	Applies to:			
	Mechanized Infantry Task No.	Armor Task No.	FIST Task No.	Artillery Task No.
Progressively increase the complexity, diversity and ambiguity of issues to be coordinated	6, 8, 22, 40, 46, 48, 55, 56, 62, 65, 69, 76	1, 2, 8, 27, 28	1-4, 30-34, 57	
Arrange for increasing complexity of matters to be expressed in communication	6, 8, 48, 55, 56, 62, 65	8, 17, 32	27, 55	
Present targets and target mixes that approach as well as retreat from trainee's position at varying speeds	1, 3, 6, 14, 16, 19, 20, 26, 30, 32, 39, 41, 44, 46, 61, 71-73	15, 18, 20, 21, 33, 38, 42, 43	11, 39, 42	

Vulnerability And Cross Training Priorities

In the ideal military organization, every incumbent of every duty position would be competent to perform each and every duty (task) of each and every other duty position. This would help to assure that no matter what the emergency, there would be someone available to perform some critical task or to help in its performance. Clearly, the ideal is not possible, but it provides a goal. The degree to which the ideal can be approximated is constrained by factors such as available time, competing requirements, etc. Within these constraints, what should be the order of priorities for cross training?

For the military organization preparing itself to meet the demands of continuous combat operations, these priorities should be determined most heavily by specific task vulnerabilities to degradation. For example, the effectiveness of performance (E) in certain tasks declines not at all or only nominally (e.g., Mechanized Infantry Task No. 27, Artillery Task No. 36), while othere promise to decline very severly (e.g., Mechanized Infantry Task No. 44, FIST Task No. 26). The complement of E, 1-E, expresses the magnitude of the decline or the degree of vulnerability to degradation. While E is inversely related to degradation, 1-E expresses it directly.

The absolute degree of vulnerability of each task and the relative degree within a duty position or type of unit (Infantry, FIST, etc.) would seem to be the prime indicator of necessity and urgency for cross training. The absolute, as well as relative degree, of task vulnerabilities are shown in Figures 8.1 through 8.4. Within these tables, tasks are categorized by type of unit and duty position. The scale of vulnerability appears on the left. Next to each scale interval, the task numbers of critical tasks falling in that interval are given.

Mechanized Infantry Task Vulnerability

For Mechanized Infantry units, the calculated vulnerability is highest for Task Nos. 39, 44, and 41 which fall within the responsibility domain of the Squad Leader's (SL) duty position. These are fire direction tasks requiring primarily complex evaluation and rapid decision making. By contrast, Tasks Nos. 5 and 27, which involve firing at areas, are minimally vulnerable. The absolute, as well as relative, vulnerability of other tasks, which fall between these extremes, are readily apparent in Figure 8.1.

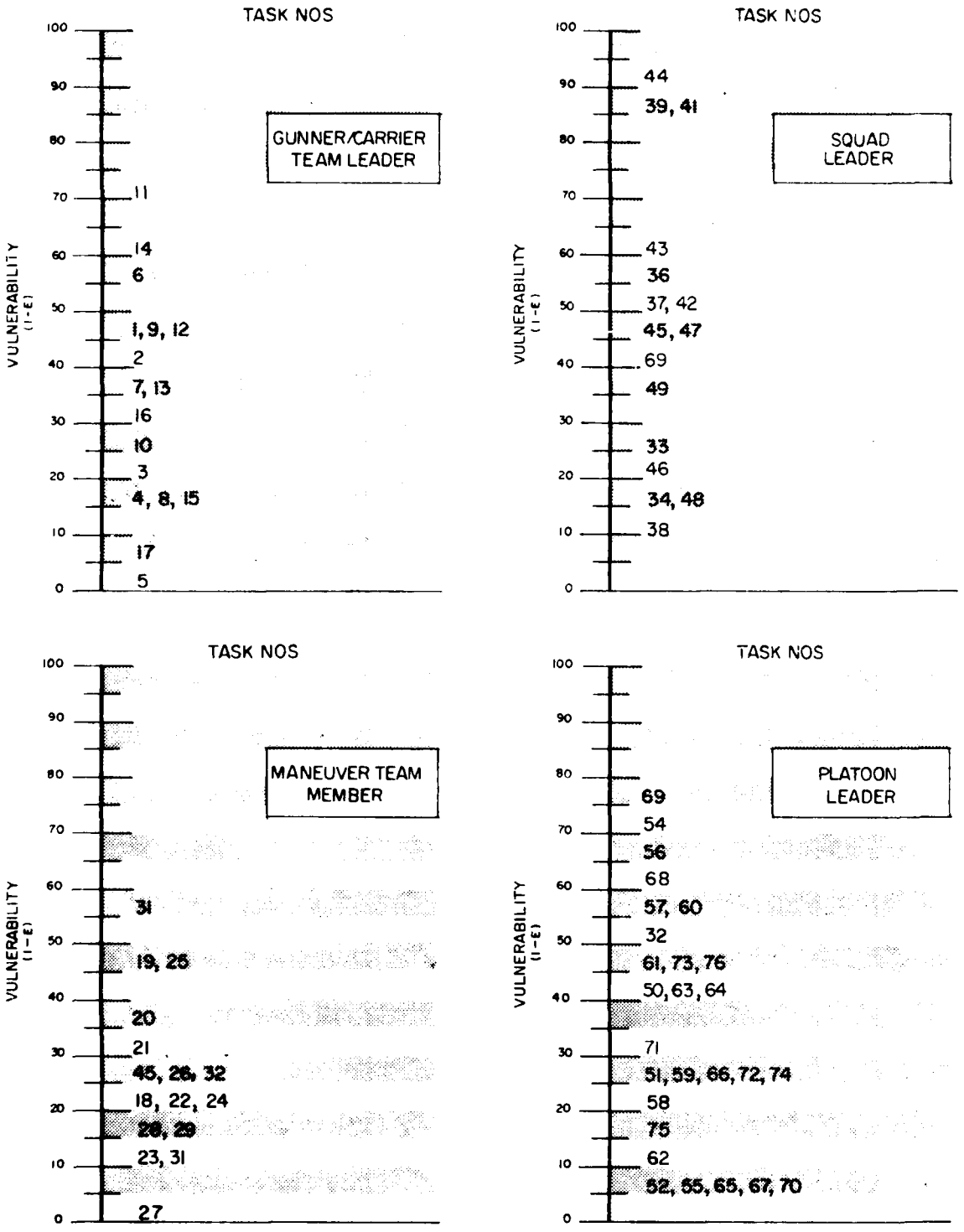


Figure 8.1. Vulnerabilities to degradation – Mechanized Infantry

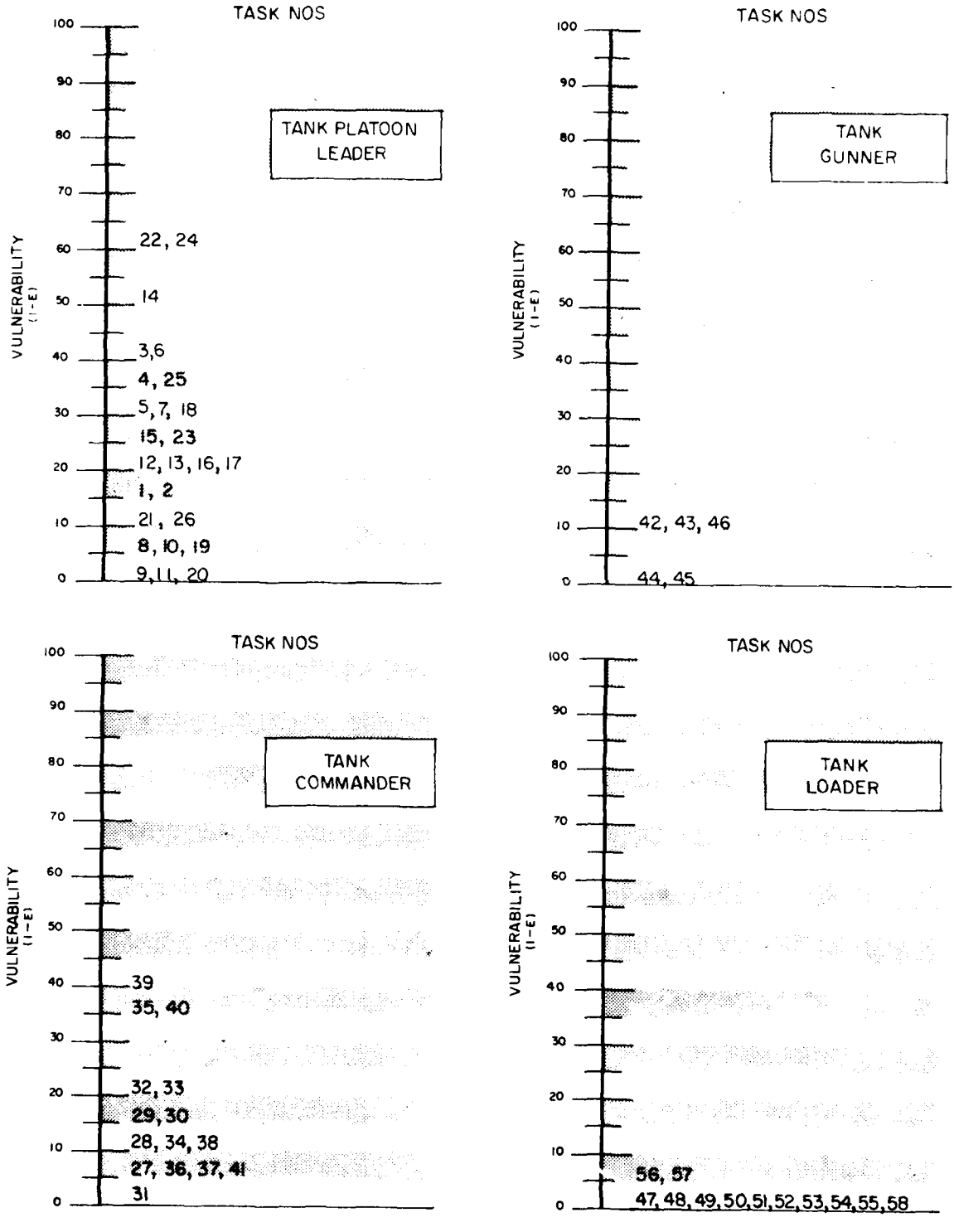


Figure 8.2. Vulnerabilities to degradation – Armor (Tank Platoon)

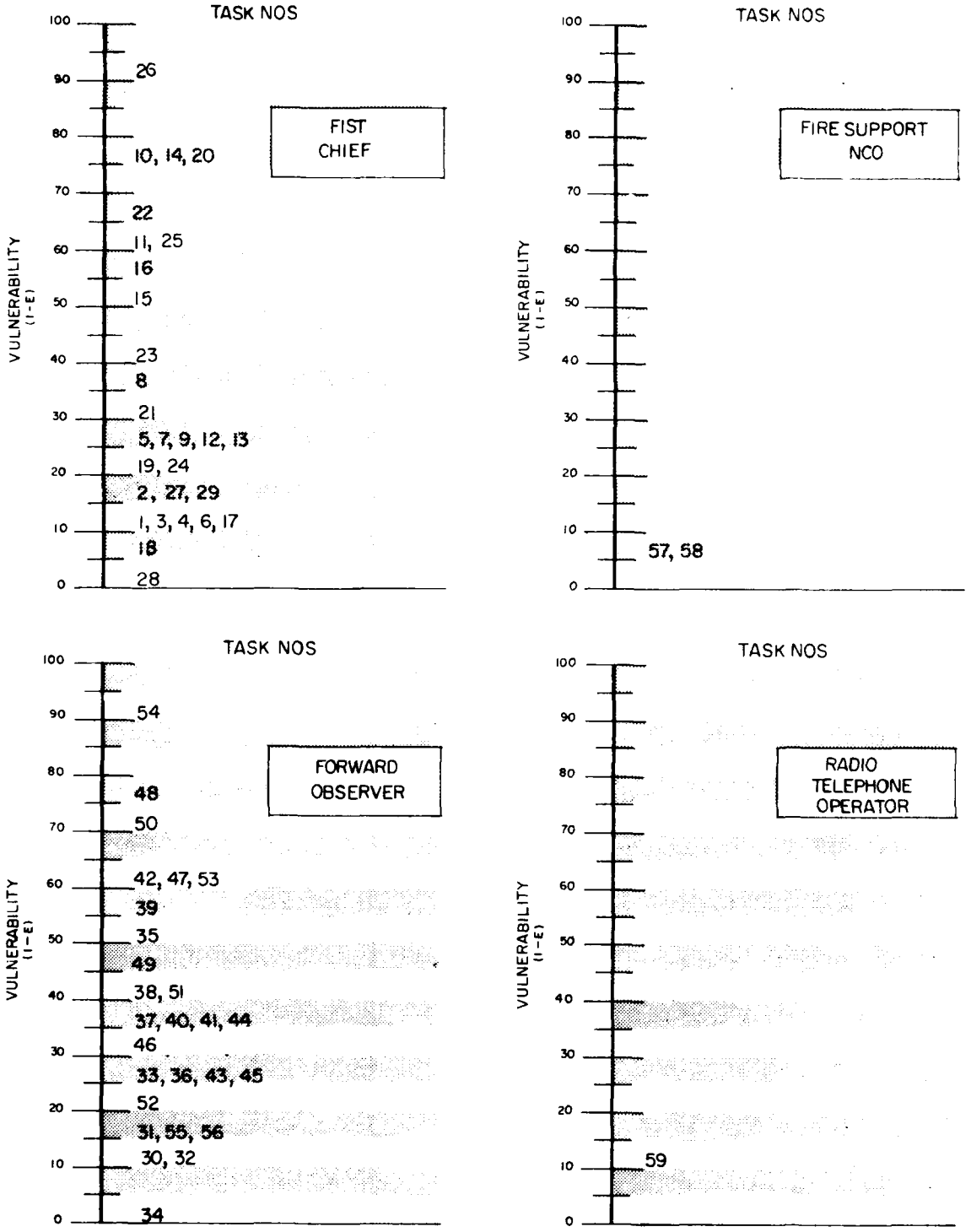


Figure 8.3. Vulnerabilities to degradation - FIST

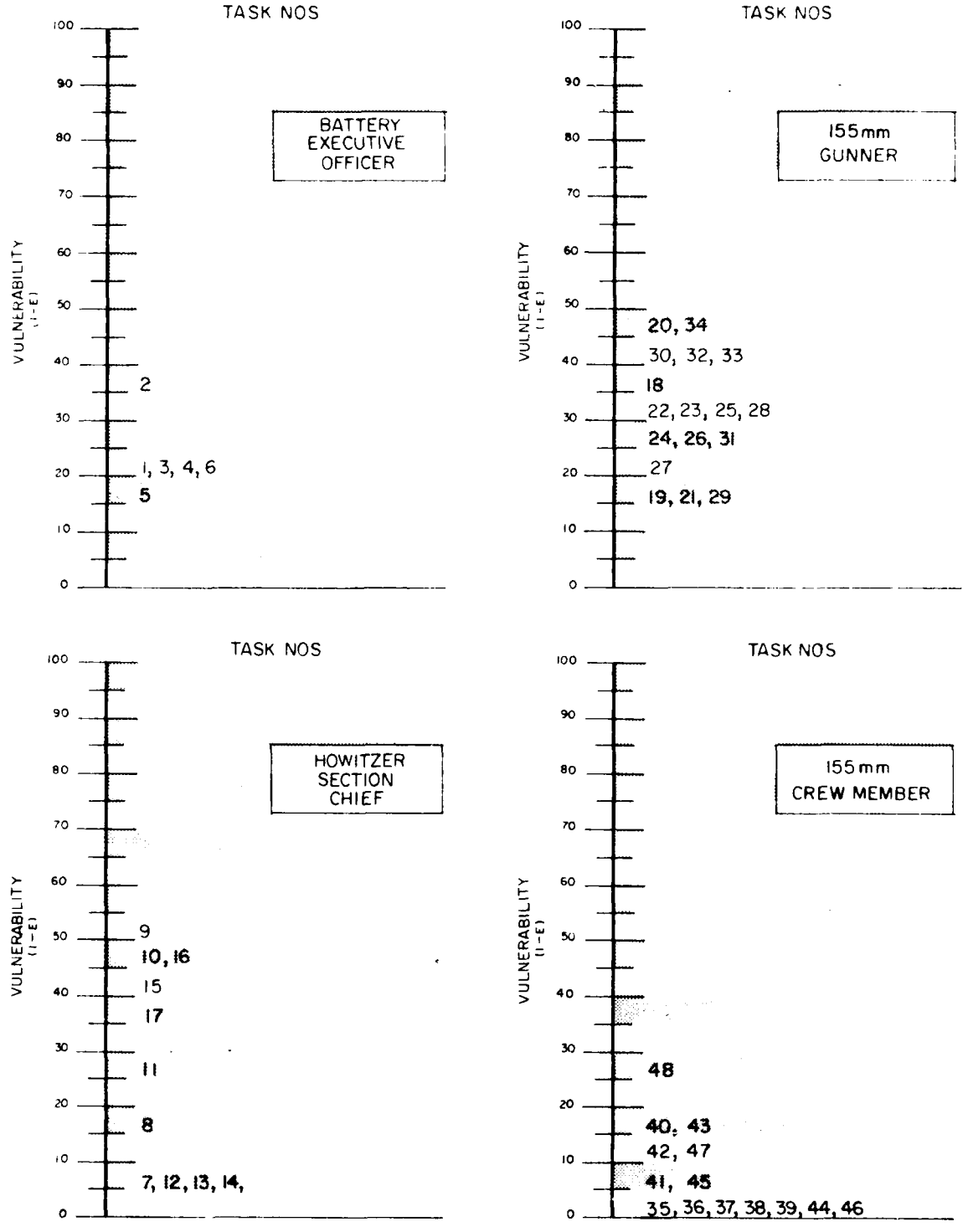


Figure 8.4. Vulnerabilities to degradation--Artillery

Armor Task Vulnerability

The pattern of vulnerabilities for tank platoon personnel (Figure 8.2) reflects the somewhat higher values of E compared to infantry duty positions. As might be expected, the highest calculated vulnerabilities appear for the Tank Platoon Leader (TK PL) whose overall pattern is not very different from his infantry counterpart. On the other hand, Tank Commanders (TK CDR) are for less vulnerable overall than SLs. The relatively low vulnerabilities of tasks performed by the Tank Gunner (TK GR) and the Tank Loader (TK LDR) are probably due to a lack of cognitive or vigilance demand.

FIST Task Vulnerability

For FIST, the highest calculated vulnerabilities occur (Figure 8.3) for the adjusting of multiple missions whether that task is performed by the FIST Chief (No. 26) or the Forward Observer (No. 54). To the extent to which identical tasks (e.g., adjust fires) are involved, the patterns for these two duty positions are also identical. To the extent to which the Fire Support NCO acts as deputy or assistant to the FIST Chief -- performs the same tasks -- his task vulnerabilities would coincide with those of the FIST Chief. The pattern shown for this duty position is confined to those tasks peculiar to it. This is true, simularly, for the Radio Telephone Operator and his role as assistant FO.

Artillery Task Vulnerability

Taken as a group, artillery tasks (i.e., 155mm Howitzer Operator) appear less vulnerable (Figure 8.4) to degradation than those of the preceding types of unit. To some extent, this result reflects the highly proceduralized and practiced character of artillery tasks. Possibly, however, the calculated pattern of vulnerabilities is somewhat attenuated by the background scenario against which the tasks are assessed. Presumably, the most difficult circumstances for the execution of these tasks would occur when multiple missions are being fired, interrupted, redirected, again interrupted and redirected, and so forth. At the same time, it must be noted that extensive cross training of gun crews is already a standard policy.

Other Determiners

Though the absolute and relative vulnerabilities of tasks should be a principal determiner of priority for cross training, it should not be the only one. Consideration must be given; also, to the degree of importance or criticality of each task (see Tables 1.2 - 1.5).

A final consideration derives from economies of the type implied by higher and lower levels of the same MOS. Assume that individuals B and C are both candidates for cross training with A. If C's tasks are very similar to A's, he may deserve priority over B (tasks less similar), because he is likely to master A's task in less time and with less effort than B.

CHAPTER IX

SYSTEM DESIGN AND PERFORMANCE SUPPORT

The possibilities offered by system (re)design and by performance supports in countering human performance degradation are examined. The alternatives or combinations of relief of demand and support for critical abilities are described. Examples are given. Needs related to required critical abilities are listed together with potential means for satisfying these needs.

The requirements for human performance are jointly determined by existing conditions and by the established system (organization) within which each person functions. Two additional categories of counteraction can be considered for counteracting the adverse effects of continuous operations:

1. reduce system demand
2. support critical abilities.

In the first approach, the requirements for sensing, information processing, or motor ability are diminished so as to reduce the required effort. In the second approach, the perceptual and/or motor capabilities of the personnel are amplified by equipment, and the information processing load is shifted in part to devices extraneous to the person.

The distinction between these two approaches exists more for ease of discussion than in reality. Also, the counteractive measures discussed in this chapter must not be considered as independent from those presented in previous chapters. Rather, counteractive provisions need to be planned and implemented in an integrated fashion. Performance supports must be considered while restructuring responsibilities (or vice versa), performance supports also affect training operations, system design or redesign interacts with both, and so forth. For example, a simulator incorporating vehicle motions and vibration, and perhaps, electronic targets and scoring might support only training of the CAL 50 gunner. However, the acquired ability to compensate for erratic vehicle motion strengthens the critical ability "Dynamic Precision" in actual combat operations.

The possibilities for effective system (re)design and for performance supports are extensive. Often, the desirable change or support may be seemingly very minor. Yet the effects may be substantial. Such minor "fixes" will occur to the inventive, interested person familiar with his own tasks and their performance. Such inventiveness and initiative should be encouraged locally and translated into practice, although with subsequent evaluation of practicality and effectiveness.

System Design

A system is the integral of the items, information, action and organization required to achieve some specified outcome. In military combat, objectives are the redeployment of forces, redistribution of material, relocation, etc. The commander's specification of who is to move to where, with what resources, for what purpose, for how long, and so on can be communicated at the time of desired execution, or it can be preplanned. Then, at the time of desired execution, the communication requirement is reduced to "execute maneuver X." All this is not new, but does constitute an excellent example of system design. The communication demands on the message originator (commander) as well as those on the recipient(s) are sharply reduced.

In anticipation of the exhaustion and degradation of human performance capabilities, the development of SOPs assumes critical importance. However, the possibilities for system design are by no means fully achieved. For example, SOPs need to be coded, and the codes must be well learned. Also, at critical times they must be communicated. The following example of efficient code development, therefore, is pertinent for the critical abilities "Memory" and "Communication." The example is taken from a Soviet manual "Military Human Factors Engineering."

Let us assume that we must remember an arbitrary code number A 2-12-85. Memorization of the series A/2/1/2/8/5 requires storage of 21.5 bits of information (the bit is a measure of information amount). Memorization in the form of A/2/12/85 reduces this very slightly to 21.3 bits. If the A is replaced by the number "1" and digits are grouped by threes, thus, 121/285, the information storage requirement drops to 19.6 bits. But, a further redesign of the code to "twice twelve" or (2)12/85 achieves a maximum reduction to 16.3 bits.

For some situations, SOPs will not have been developed and verbal messages must be formulated. The demands on the communication ability of, both, message originator and recipient will be reduced, if messages are composed from a limited, standard vocabulary. The smaller the set of possible message elements (words), the easier is formulation and comprehension of the message.

While the examples given here were drawn from the context of communication and memory, this should not be thought to represent all of system design. All facets of systems can be improved to reduce demands on critical abilities. Nor should a single round of improvements be thought to exhaust the virtually infinite number of possibilities. System improvement should be a continuing process of "chipping away" at error sources.

Performance Supports

If system (re)design is analogous to reducing the weight of an object, performance support is analogous to providing a lever. Either the human capability is amplified by a device, or the demand is advantageously divided between the person and the supporting device. For example, even when a highly efficient code has been developed, a code list or a note pad will relieve the memory demand on the person.

Performance supports already exist. For example, binoculars and night vision devices (NVDs) are in widespread use. Certain performance supports are available from standard Army stock through its supply system. Others may require special procurements. Still others can be specified functionally, but realizations remain to be developed.

Relief/Support for Critical Abilities

Because the circumstances generated by and inherent in continuous operations serve to diminish or depress abilities important to the performance of critical combat tasks, it becomes especially important to support these abilities. System design and performance support possibilities are outlined and exemplified below. These suggestions have been categorized by principal supported ability, but many schemes and devices cut across these categories. The list is not exhaustive. Rather, it is intended to stimulate the creative initiative of those most intimately familiar with what is needed.

Definitions given hereafter for the various abilities are the same as those given in Chapter I. They are repeated for convenient reference.

Communication--the ability to transfer required and/or relevant information in proper depth and scope at the the proper time.

Need	Potential Realization
1. Prompts for the (likely) message elements in their appropriate order(s).	1. Check lists of standard message elements, i.e., prompts.
2. All nonredundant or variable message elements need to be recorded and repeated.	2. Standard messages in standard formats requiring only variables (blanks) to be filled in.
3. Method for separating and coding message categories as to importance, type, urgency, etc.	3. Precede message transmission with clearly and easily identifiable marker signal (e.g., beeps of distinctive pitch).
4. Minimum, adequate standard vocabulary.	
5. Nonverbal communication channels.	5. Visual signals; also, electro-cutaneous ("touch") communication device.

Dynamic Precision--the ability to maintain body balance and make accurate aiming movements while the body is in motion

Need	Potential Realization
1. Stabilization and damping of motions in the platform on which the person stands.	1. Rapid, electronic/hydraulic dampers (shock absorbers) for shooting platforms in vehicles.
2. Stabilization and damping of weapon used by a person.	2. Rigid frame work to brace person and/or plastic air bag for use as rifle rest.
3. Practice under dynamic conditions	3. Simulator incorporating vehicle dynamics to allow training in accurate fire when vehicle is tilting or vibrating.

Hearing--the ability to detect and identify significant sounds amid competing sounds

Need	Potential Realization
1. Attenuate noise and especially masking noises.	1. Rubber ear canal plugs or sound reducing over-the-ear protection/ head phones.
2. Amplify faint sounds and/or portions of the audible spectrum.	2. On-ear or in-ear hearing aids incorporating filters adjustable to sound signatures of threat forces equipment.
3. Clip peaks of electronically transmitted vocal signals and/or reduce high and low frequency components.	3. Clipping and hi-lo filters.
4. Assure clarity of transmitted verbal signals.	4. Midrange sensitive, directionally shielded microphones.
5. Method for providing redundant information through other sense modalities.	5. Hand signals, light signals, cutaneous (touch) signals.
6. Means for accurate classification on basis of auditory information.	6. Hand held spectrum analyzer

Memory--the ability to remember (recognize and/or recall) information such as words, pictures, and procedures

Need	Potential Realization
1. Encode information to be remembered (recognized or recalled) efficiently.	1. Develop efficient codes, message schemes, vocabularies, etc. and or overtrain (overlearn) SOPs, message schemes, etc.
2. Maximize recognition and minimize active recall requirements.	2. Provide quick look check lists, reference manuals, pictures, or charts.
3. Means external to the person for information storage and retrieval.	3. Note pad, (micro)-cassette recorder, printing terminal to receive and print incoming information.
4. Means for regenerating information, instead of storing it.	4. Nomographs, slide rules, curves.

Numerical Facility--the ability to add, subtract, multiply, and divide numbers (including when they are part of other questions such as finding percentages or cosines)

Need	Potential Realization
1. Need to minimize or eliminate requirements for "mental" arithmetic.	1. Hand held calculators; sets of "*rules of thumb*" for checking calculations.
2. Need to reduce requirement for correctly ordering problem solution steps.	2. Calculator preprogrammed for standard numeric problem types.

Orientation--the ability to orient and find one's way about in three dimensional space as well as assessing the location of objects in that space

Need	Potential Realization
1. Means for abstracting and recording the position of critical points.	1. Maps and charts, plexiglass slate, grease pencils, and wiping rag.
2. Means for determining distance and direction of movement.	2. Compass, pedometer.
3. Representation of surrounding space, objects in it and the orienting person's momentary position.	3. CRT or similar terrain display with blip marking present position (e.g., driven by on-board computer in APC, task, etc.)
4. Practice in maintaining orientation.	4. Proving ground or simulated battle field for training in orientation maintenance.

Perceptual Speed--the ability to compare letters, numbers objects, pictures, situations or patterns, present or remembered, both quickly and accurately.

Need	Potential Realization
1. Facilitate mainly visual comparisons of actual and remembered objects (targets).	1. Provide line drawings and/or silhouettes of enemy equipment with distinctive features emphasized; provide pictorial representation of similar appearing friendly and enemy equipment (BMD, tanks, aircraft) overlaid or overlayable on each other; also, from various angles of view.
2. Means for detecting change and amount of change for defined situations.	2. Computer driven status display showing (at option) only changing elements plus duration or distance of change.

Reasoning--the ability to apply rules to problems and to derive answers or decisions, or to combine units of information to form a rule or to produce a set or rules necessary to arrange things or actions in order.

Need	Potential Realization
1. Solution aids for various classes, (kinds) of problems encountered in combat operations.	1. Steps leading to solution - in their proper order - outlined on paper (booklet, cards, etc.); prompts associated with each step and which call for users to furnish the required data (numbers, observations, quantities, etc.); decision trees in printed form--user needs only to choose correct branch at each decision point.
2. Decision aids to calculate utility (i.e., comparative desirability) of competing courses of action, or of probability of class membership of observed object (e.g., friendly vs enemy target).	2. On-board micro-computer (in APC, tank, etc.) preprogrammed for most standard combat decision problems; user specifies problem type and furnishes input data.
3. Practice in realistic problems.	3. War gaming boards for use at unit level

Vision--the ability to detect visually objects and relations among objects such as movement or relative distances

Need	Potential Realization
1. Amplify distance vision	1. Binoculars; miniature ("hand held") radars
2. Enhance target contrast	2. Polarizing and similar types of optical filters
3. Shift or alter colors	3. Red, green yellow, blue optical filters
4. Amplify night or dark vision	4. Night vision devices; miniature ("hand held") radars
5. Amplify evident movement	5. Optical lenses which distort and, therefore, enhance angular displacement of moving objects
6. Reference frame for field of vision	6. Standard grid or transparent medium at standard distance from eyes to aid in judging vertical and lateral distances and angles

CHAPTER X

WORK REST SLEEP MANAGEMENT [1]

The effects of progressive sleep deprivation on human performance are summarized. Types of tasks most affected, duty schedules, recovery requirements, and similar matters are discussed as well as listed in tabular form. Recommendations for rest and sleep discipline are presented.

The effect of sleep loss on performance varies widely from essentially no effect to an almost complete breakdown in performance. As stated earlier, the effects are a function of many factors, including the individual experiencing the sleep loss, the time (phase) in the diurnal cycle, the activity prior to and during the sleep loss period, the performance reserves remaining available to the individual, and the nature of the work being performed.

Task Interest and Complexity

Within broad limits, the crucial variable in predicting the extent to which sleep loss will affect performance is the factor of interest. The impact of sleep loss is more pronounced when the tasks involved cease to evoke interest.

In general, performance on monotonous tasks involving relatively simple skills deteriorates markedly as a result of acute sleep loss greater than 24-hours duration. This tends to be less true as the tasks become highly automatic. Monotonous tasks requiring, for example, detection of faint or low level signals (e.g., targets on a radar scope) over several hours frequently show performance decrements greater than 50 per cent of initial capability. Increasing task complexity to the extent that it may serve to increase interest without raising difficulty to too high a level may often result in less severe sleep loss effects.

Simply increasing task complexity, however, (such as by promoting uncertainty) without a concurrent increase in interest will result in greater performance decrement after sleep loss. At the same time, interesting tasks such as games or challenging tasks in which the participant knows how well he is doing and which involve common perceptual-motor skills, appear resistant to the effects of sleep loss for periods of as much as 60 hours.

---

[1] The content of this chapter is adapted from a report prepared by D. P. Woodward (Office of Naval Research) and Captain P. D. Nelson (Naval Medical Research Development Command) for The Technical Cooperation Program (Australia, Canada, UK, US).

Difficult tasks, those defined as involving high work load, will be more sensitive than easy tasks to the effects of sleep loss. One must be aware of interaction effects here, since a difficult but interesting task probably will be less affected than an easy but monotonous task.

Type of Task

The type of task in which the individual is engaged is a significant factor in judging sleep loss effect. Conditions, such as extended periods of time spent on the task without rest or change of pace, are another significant factor. Tasks that tend to be repetitive, less immediately rewarding and less interesting, are also most likely to show performance decrement as time on task increases and rest periods or breaks in routine are decreased or not permitted at all.

It is not advisable to ask individuals to learn new things, e.g., facts of a discrete nature, until they have fully recovered from sleep loss of 24 hours or more. Experimental data clearly show impairment in acquisition and immediate recall of newly learned material. At the same time, a 24-hour sleep loss appears to have little effect on the recall of material which was learned previously. The fact that skills which have achieved the status of being almost automatic or "second nature" suffer less from the effects of sleep loss than do newly learned skills suggests, of course, that the individual be very well trained in the execution of whatever tasks he will be expected to perform if the sleep loss effects are to be minimized.

In one study, after four days and nights without sleep, subjects were unable to read completely a sentence of more than 30 words; they would lapse before finishing it. A consistent finding in studies involving sleep loss is the occurrence in perceptual performance of brief intermittent lapses that increase in both frequency and duration as sleep loss progresses. A lapse is defined as a pause that is more than twice as long as the average or typical time taken to respond.

The specific effect of lapses on performance varies with the properties of the task and with the task environment. In self-paced tasks (i.e., those in which the worker sets the pace of responding) speed of response seems to be critical: the person tends to slow down while maintaining high accuracy. In work-paced tasks, errors appear to be the critical measure. In such situations, errors tend to be of omission or missed signals.

As sleep loss continues, errors appear progressively earlier in the task and the benefits of breaks become increasingly short-lived. Extensive data from laboratory and simulated work sessions have recently been further supported by data involving real highway driving tasks; after sleep loss, the same sorts of effects are found in that more road signs are missed, normally detected and avoided obstacles (such as tires in the roadway) are struck more often, and weaving (or inadvertent lane changing) increases.

Sleep loss has a differential effect on various aspects of the communication tasks that have come to play an increasingly important role in most systems. In giving instructions, the time required for sending information increases with sleep loss; the number of errors made also increases significantly, although these errors typically are corrected. On the other hand, in receiving instructions, errors of omission increase significantly with sleep loss.

Mission Duration

How long it is possible to continue working before performance decrement sets in? As with most questions of this sort, there is probably no single answer that will apply to everyone under all conditions and work situations. There is, however, an adequate body of data which indicates that during periods of 36 to 48 hours of continuous work, with no sleep, and a work period beginning between 0800 and 1200, major performance, decrements first appear after approximately 18 hours. This coincides with the low segment of the typical diurnal cycle which occurs at about 0200-0600 hours.

It is important to note the specificity of the starting time and the condition of continuous work. Measures of sleep-loss duration are based on reports of the hours of prior wakefulness and 16 or 18 hours of wakefulness are daily experiences for many of us. Continuous work, however, is probably less frequently encountered. Different starting times will result in different times of decrement appearance, most likely determined in part by the phasing of the diurnal rhythm. Experimental data from studies involving periods of 36 to 38 hours of continuous work with no sleep suggest that performance is particularly sensitive to the fluctuation of diurnal rhythm.

Performance during continuous work generally appears to show increasing impairment as the number of hours spent awake increases, but the impairment is subject to a superimposed variation from the influence of diurnal rhythms. Again, individual differences are great, as is the influence of the type of task. Individual curves will quite often show rather sharp performance decrements at various points, following sleep loss of 24 hours or more. However, these points are not consistent. A useful guideline may well be to expect fairly steady performance decrement as the number of hours awake increases, with worst performance most frequently found between 0200-0600 hours.

In a simulated work situation involving a number of different tasks, it was found that average performance decrements as great as 40 per cent below baseline levels can be expected toward the end of a 48-hour period of continuous work with no sleep, breaks, or catnaps. Typically, the poorest performance can be expected during the early morning hours (0200-0600); the performance will be especially poor if the end of a 48-hour sleep loss period

occurs during these early morning hours. It should be noted that the decrement is referenced to baseline performance, which itself may not represent the best possible performance. Thus, in terms of absolute performance change (e.g., total number of targets not detected, rather than the number below average), the decrement could be much greater. Note should be taken that values of the effectiveness index (E) throughout these Guidelines reflect precisely such a decline from baseline (routine, normal) performance rather than an ideal of "best possible" performance.

A critical factor affecting performance after periods of sleep loss is the uninterrupted length of time that the same task stimuli occur and the same response is required. In a sense, this observation is consistent with the above observations regarding task duration and inherent interest, in that tasks involving the same stimuli and responses are more likely to be repetitive and boring.

The performance impairment associated with sleep loss is accentuated as a function of time on task during the continuous operation of a single task. There is an interaction between task duration and sleep loss in that the effects of acute sleep loss are generally greater for longer duration tasks. Experimental data indicate that following one night of sleep loss, performance will tend to "bottom out" after about 30 minutes time on task, and will show relatively little additional impairment during the next 30 minutes.

There are data which indicate that lapses similar to those resulting from sleep loss also occur under fatigue resulting from extended periods of time on a given task without rest or change of pace. This may be, in part, a function of the type of task and/or the variation or lack thereof in the task. Breaks in a task appear to delay the occurrence of sleep loss induced performance lapses until the later stages of the work period. Such breaks apparently help to return performance lapses until the later stages of the work period. Such breaks apparently help to return performance to the initial level. Performance shortly after the break, however, again shows a decrement.

In general, lapses resulting from sleep loss are strongly affected by stimulus monotony in that the more monotonous tasks seem to be related to more frequent lapeses. At present, it is not clear if this sort of lapse has the same underlying dynamic characteristics as those found with more varied stimulation.

As sleep loss increases, performance becomes more uneven, with periodic lapses in efficiency being more characteristic than a continuous depression of performance. This follows from the basic idea that if a lapse were to occur at the time a target was to be detected, the target would be missed.

Reaction time refers to the interval between the appearance of some signal for action (e.g., appearance of a target) and the initiation of action appropriate to that signal. Sleep loss persistently produces an increase in reaction time that is reflected in progressively greater unevenness of performance, and in an increase in the variability of the reaction-time distribution.

Increases in reaction time are strongly related to increasing hours of sleep loss; after 78 hours without sleep, average reaction time is twice as long as that noted on the day immediately prior to the start of the mission. The word "average" is emphasized for a reason; when the best reaction time responses are examined, it seems clear that these increase only slightly over baseline, while the poorest performance become consistently worse. Therefore, when all the reaction times are evaluated, the average tends to increase or become longer.

Many work situations will involve more than one task. When this happens, one of the tasks is usually considered primary either by the investigator or by the subject. If the work is such that it is at or near the performance load capability of the operator, then performance on additional, or secondary, tasks will be especially susceptible to the deleterious effects of fatigue and sleep loss. The operator will attempt to maintain his level of performance on the primary task at the expense of poorer performance on secondary tasks. There are data, however, which suggest that when all tasks are weighted equally in importance, then performance decrements on all tasks will be about the same.

As noted above, there are wide individual differences in the kind and degree of performance degradation resulting from sleep loss. The relation of these differences and of the effects to intelligence and personality has been repeatedly investigated. No relationship has been found. Intelligence, education, background do nothing to diminish the adverse effects. Sleep-loss also seems to have a negative effect on mood or disposition, as evidenced by self-reports of increased feelings of hostility, irritability and depression. However, this may be as much the result of the individual's attitude toware the situation as of the sleep-loss as such.

A summary of this information appears in Tables 10.1 and 10.2.

Amount of Sleep-Loss Required to Degrade Performance

How soon can the effects enumerated in Table 10.2 be expected to manifest themselves? How much sleep can men go without before performance is degraded? Table 10.3 summarizes the available information pertinent to these questions.

Table 10.1

Tasks Most Vulnerable to Sleep-Loss Effects

- Uninteresting and monotonous tasks
- Tasks that are new or require learning on the job
- Work-paced tasks (as opposed to self-paced tasks)
- High-workload tasks that require time-sharing with other primary and secondary tasks
- Tasks that require continuous attention and steady performance
- Tasks in which the worker has little feedback on his performance
- Tasks with heavy cognitive components (reasoning, problem solving, decision making, evaluating information

Table 10.2

Types of Performance Degradation Most Likely from Sleep Loss

- Slower reaction time, increased time to perform known tasks
- Short-term memory decrement, impairment in speed of learning
- Impairment in reasoning and complex decision chain
- Errors of omission, lapses of attention
- Increased feelings of fatigue, irritability, depression
- Erratic performance or increased variability in proficiency

Table 10.3

Amount of Sleep Loss Required

to Degrade Performance

- 24 hours on routine and monotonous tasks or new skills
- 36-48 hours on most tasks involving cognitive and perceptual skills
- 50 per cent/24 hours cumulative reduction of normal sleep time over one week
- 4-6 hours if working 0200-0600 watch after day of continuous work
- 24 hours if sleep loss is imposed on one week of "4 on - 2 off" work-rest schedule
- 24 hours if sleep loss is imposed on two weeks of "4 on - 4 off" work-rest schedule

Work-Rest Schedules and Performance

As previously noted, one of the factors that influences the effects of sleep loss on performance is the work-rest schedule followed before and after a period of acute sleep loss. A few selected comments are appropriate. Work-rest schedules are presented, typically, in the format "4 on - 4 off," "2 on - 6 off," etc. This should be read in the first instance as "four hours on duty followed by four hours off duty" and in the second instance as "two hours on duty followed by six hours off duty." The majority of workers, military or civilian, probably work an "8 on - 16 off" schedule or some reasonable approximation thereof under normal circumstances.

The possible similarity of off-duty and on-duty activity should also be noted. It should be equally clear that the nature of the work activity during an on-duty period is an important variable and should be considered in establishing a work-rest schedule. Further consideration would include the extent to which the work allows for breaks, i.e., brief nonwork periods, and whether the tasks to be performed are self-paced, or if the person must perform in accordance with the demands of the task.

For periods of up to five days, work-rest schedules of "2 on - 2 off," "4 on - 2 off," "4 on - 4 off," "6 on - 2 off," "6 on - 6 off," "8 on - 4 off," and "8 on - 8 off," can be maintained equally well in terms of performance decrement.

Work-rest schedules of "4 on - 4 off" and "16 on - 8 off" can be maintained equally well in terms of performance effectiveness for a period of up to two weeks so long as no period of acute sleep loss is experienced, and none of the typical "housekeeping" extracurricular tasks have to be performed.

For periods greater than two weeks and up to 30 days, a "4 on - 4 off" schedule is superior to a "4 on - 2 off" schedule in terms of performance effectiveness. Under normal conditions, performance differences may not be great. Under stressful conditions, however, "4 on - 2 off" and "6 on - 2 off" schedules tend to result in poorer performance than do those which allow for longer off-duty periods. There are also data which suggest that for work periods over two weeks long, the "4 on - 2 off" schedule results in lengthening of the 24-hour diurnal rhythm and a corresponding change, with about a 2-hour lag, in performance effectiveness.

When a period of acute sleep loss greater than 24 hours is experienced under continuous work-rest schedules of "4 on - 2 off" or "16 on - 8 off," the "4 on - 2 off" worker is most vulnerable, in terms of maintaining baseline performance, and slowest to recover, while the "16 on - 8 off" worker is least vulnerable and quickest to recover.

Adaptation in biological rhythms to atypical work-rest schedules generally requires a three- to four-week time period. Adaptation may be enhanced, however, if the individual can synchronize his sleep with the sleep phase of the atypical schedule as quickly as possible. It is obviously easier for a person to work when he is tired than it is for him to sleep when he is alert and rested; therefore, adaptation will be enhanced if he can start on the new sleep cycle as soon as possible. Probably the best way to maximize the likelihood of this happening is to have the person stay awake sufficiently long to ensure his being in a low-alertness condition when the sleep period of his new schedule comes around. This relatively simple solution to problems of adaptation to new schedules seems to work fairly well, especially in the case of transmeridian shifts such as are experienced in eastbound flights. A period of three to five days typically is required for initial adaptation; a complete phase shift takes three to four weeks on average.

Duty Schedules Most Vulnerable to Performance Degradation

Under what types of duty schedules is performance degradation most likely to occur? These schedules may also affect performance decline in subsequent continuous duty. A summary of this information appears in Table 10.4.

Table 10.4

Duty Schedules Most Vulnerable to Performance Degradation

- Continuous, uninterrupted time on task for several hours duration
- Work period between 0200-0600 hours (unless person is specially prepared)
- Night-shift work with person having had less than three to five days on the night shift
- Day and night shifts rotated on consecutive days
- Work periods of around the clock with 2-hour intervals
- First postsleep work period immediately following continuous duty

Recovery from Sleep-Loss Effects

Given that sleep loss occurs, how long does it take to get over the effects and what conditions enhance recovery? The problem of recovery from sleep loss has not been explored nearly as extensively as have questions relating to sleep-loss effects or work-rest schedules. Correspondingly, the

suggestions which follow will tend to have a smaller number of scientific studies to support them. Most notable for their absence are studies on the degree of performance recovery that can be expected when only a fraction of the total sleep-rest time required for recovery can be granted (e.g., cat naps). Such information, while of extreme importance to sleep management in continuous operations, does not exist at present.

Clearly, the most direct way to avoid the performance degradation that results from sleep loss is to provide adequate sleep. One way of implementing this obvious fact is to arrange appropriate work-rest schedules which provide sufficient off-duty time in large enough blocks to permit adequate sleep. Frequently, in scheduling certain operations, it is possible to anticipate that a prolonged-work or sleep-loss period will occur. If this is the case, then it is recommended that the 12-hour period preceding such a prolonged-work or sleep-loss period be kept free of duties. Ideally, this time should be spent in sleep to build up performance reserves and thereby minimize the performance decrements during the later sleep-loss period. Operational requirements may preclude executing this recommendation, but it should should be followed to the extent it is possible to do so.

If a period of acute sleep loss is experiended, the question naturally arises as to what should be done to return the personnel to what is essentially a presleep-loss condition. An estimate must be made on how much sleep is necessary to provide recovery from the effects of sleep loss. Once again, factors such as individual differences, diurnal rhythm and duration of sleep loss, must be taken into consideration.

A few generalizations, derived from laboratory and synthetic-task investigations, appear to be valid. Less than six hours of sleep is usually inadequate for full performance recovery following a period of 36 to 48 hours of continuous work with no sleep. In fact, for a large number of subjects in one study, eight hours of sleep was not adequate for full performance recovery.

The recovery of performance from acute sleep loss of up to 48 hours is generally complete after 12 hours of rest, although subjective fatigue is reported until after the third full night of sleep. Sleep loss of more than 48 hours (i.e., on the order of 72 or 96 hours of sleep loss) probably will require more than one full night of sleep before performance recovery is complete, and most certainly will require more than one night for the diurnal rhythm to return to "normal."

If a period of 36 to 48 hours of continuous work is imposed on a normal load of eight hours per day, e.g., a 4/4/4/12 or 8/16 work-rest schedule, 12 hours of rest appears sufficient for recovery to within five percent of baseline performance. However, if the same load is imposed on a work load of 12 to 16 hours per day (as in a 4/4 or 4/2 work-rest schedule) it takes about 24 hours of rest for recovery to within five percent of baseline performance.

On the basis of these data, it appears that performance recovery after acute sleep loss will not be achieved by most individuals unless they have at least eight hours of sleep. It is extremely important, therefore, that if men have endured a stressful period of sleep loss, then gone to sleep, they should not be awakened for duty until they have obtained adequate sleep unless one is prepared to accept very low performance efficiency in their work.

A summary of this information appears in Table 10.5.

Table 10.5

Time Required for Recovery from Sleep Loss and for Adjustment

- 12 hours sleep-rest before prolonged work period
- 12 hours sleep-rest after 36-48 hours acute sleep loss (subjective fatigue may linger for three days)
- 24 hours sleep-rest after 36048 hours sleep loss with high work load (12-16 hours per day)
- Two to three days time off after 72 hours or more acute sleep loss
- Three to five days to initiate biological adaptation and return to normal day/night cycle from night shift work
- Three to four weeks for full adaptation of biological rhythms to atypical work-rest schedules (as in night shift work)

A graphic summary is given in Figure 10.1. In Figure 10.1, slashed lines suggest the range of variability in required/recommended recovery time.

Methods for Counteracting Sleep-Loss Effects

The chief practical problem with the performance decrement resulting from loss of sleep and with its management is that the only truly effective cure is sleep itself. At one time, it was thought that certain stages of sleep, especially those classed as deep sleep, had greater recuperative effects than the less deep stages. Recent data, however, suggest that it is the absolute amount of sleep, rather than the amount of time in any particular stage of sleep, that is critical for performance recovery.

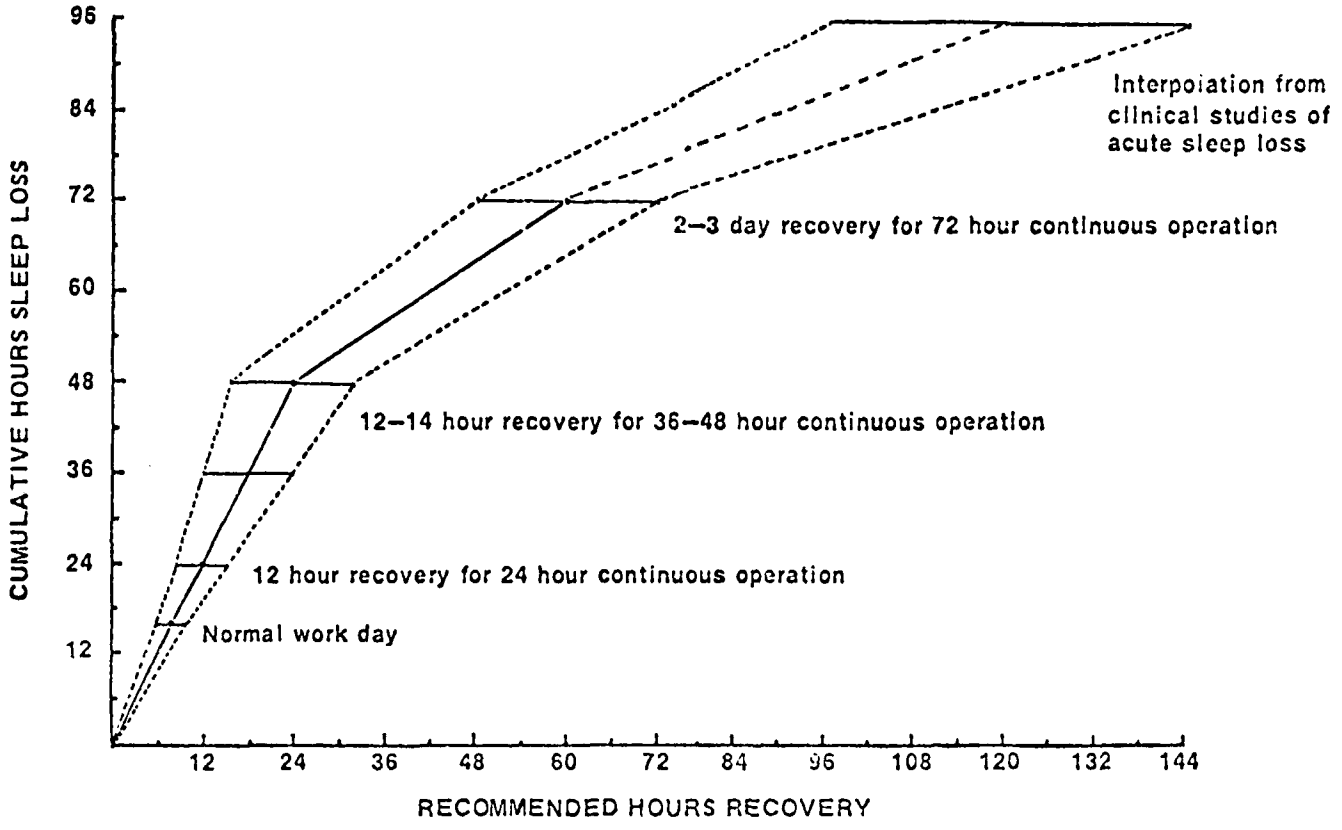


Figure 10.1. Summary: As cumulative hours sleep loss increases, so does ratio of hours recovery/hours sleep loss (and its variability as a function of individual/situational differences).

Considerable publicity has been given to the possible use of meditative procedures and learned techniques for controlling physiological processes within the body as ways of overcoming the performance degradation resulting from various stressors, including acute sleep loss. The data from controlled investigations of the meditative techniques are, as yet, equivocal. Subjects report feeling better, more rested, etc., but the performance data do not reflect any beneficial effects.

Rotation of tasks among cross trained crew members is one technique that has been used to prevent fatigue and performance deterioration during work. The benefits to be derived from task rotation are influenced by the type of task involved, time on task, extent of sleep loss, and level of training of the various crew members. In general, performances on tasks that are relatively routine, boring, and not too demanding intellectually seem to benefit most from task rotation. This also seems to be true for work situations that normally involve extended periods of time on a task. In both instances, the benefits may be simply a result of a changed stimulus, and in that sense somewhat analogous to the effect of breaks on reducing the effect of lapses as discussed above.

Rotation of tasks among cross trained crew members during a given workshift is least beneficial, and may even be detrimental, if the tasks involved are of a complex cognitive nature involving decision making. This is not necessarily true when the crew members are well practiced and expert at shifting functions, as would be the case with an artillery Fire Direction Center (FDC), for example.

Performance effectiveness during continuous work periods of 36 to 48 hours, with no sleep, may be facilitated by task rotation among cross trained crew members, especially if such rotation results in a lower overall work load for the person. There is, however, some questions as to how lasting the effect would be, as well as whether or not it would be effective with longer periods of sleep loss.

As a general rule, the use of stimulant drugs may obviate some of the drops in performance associated with sleep loss. D-amphetamine is probably the most powerful stimulant drug used to any extent. While there is little question that stimulants have an arousing effect and are generally beneficial in terms of improved performance, there are serious drawbacks to their use. For example, response to a stimulant is highly individual and dose dependent. Really effective use would require knowledge of the individual's reaction to a given dose under given conditions. Such information is rarely available in operational situations. Were the appropriate information available, however, stimulant drugs might well be an effective way to maintain alertness over periods of as long as 36 hours of continuous work without sleep. Mass administration of stimulants, or prolonged or frequently repeated usage, cannot be recommended, however.

It has often been observed during studies of sleep deprivation that a good way to revive a flagging subject is to take him for a walk or otherwise exercise him physically. The exercise should be of a relatively mild nature since rigorous or demanding physical activity is more likely to result in increasing the effects of sleep loss and possibly further depleting performance reserves.

We might reasonably expect that adding another stressor to an already stressful situation would lead to greater performance degradation. Although all the data on combined stressor effects on performance are equivocal, there does seem to be sufficient data to indicate that the effects of multiple stressors are not simply additive. Laboratory studies have demonstrated that continuous or intermittent very loud noise tends to increase the error rate and variability in the rate at which work is completed on a variety of tasks. Acute sleep loss tends to have the same effect. However, combining the stressors will not necessarily result in a total number of errors equal to the sum of their individual effects.

There are some data which suggest that noise, as described above, may even counteract to some extent the effects on performance of up to 24 hours of sleep loss. It is doubtful that this would hold true for as much as 48 hours of sleep loss. This observation may not be pertinent if the operational situation is already rather noisy as when individuals are running various pieces of motorized equipment, rifle firing, and the like. In otherwise quiet situations, such as are found occasionally in monitoring tasks, it may have some validity.

Procedures for Reducing Performance Degradation in Continuous Operations

How can the risks of incurring degraded performance due to sleep loss be minimized? What means, apart from sleep (or cat naps) itself, are there for counteracting fatigue? A summary of this information appears in Table 10.6.

Finally, it cannot be stressed sufficiently that those most in need of sleep are persons--regardless of rank or background--who must make decisions or plans. The survival of any military unit and of its individual members depends on "clearheaded" reasoning. Therefore, the maximum of sleep-rest that can possibly be spared should be allocated to such persons.

Table 10.6

Procedures for Reducing Performance Degradation in Continuous Operations

- Periodic breaks in task and mild physical exercise or recreation
- 6-8 hour continuous off duty time per 24 hour period
- Task rotation among cross trained crew on relatively routine jobs
- Task rotation among crew on complex tasks only when members are highly trained to shift functions
- Selection of personnel who prefer and are able to adapt to different work schedules
- Training on complex tasks to a high degree of "over learning"
- System design to compensate for types of errors most likely to occur
- Plan for and provide naps where possible

APPENDIX I

GLOSSARY OF MILITARY ABBREVIATIONS USED IN SCENARIO AND TASK LISTS

Abbreviation	Definition
AD	Air Defense
AMMO	Ammunition
APC	Armored Personnel Carrier
ARTY	Artillery
ASACO	Army Security Agency Company
AT	Anti-Tank
ATGM	Anti-Tank Guided Missile
BMP	Threat Infantry Combat Vehicle
BP	Battle Position
Br/BDE	Brigade
Btry/BTRY	Battery
CBR	Chemical/Biological/Radiological
CBT	Combat
CEOI	Communications/Electronics Operating Instructor
CFA	Covering Force Area
CLGP	Cannon Launched Guided Projectile
CO	Commanding Officer
COAX MG	Coaxial Machine Gun
COMEX	Communication Exchange
CP	Command Post
Div	Division
DR	Driver
DS	Direct Support
Engr	Engineers
FA	Field Artillery
FDC	Fire Direction Center
FEBA	Forward Edge of Battle Area
FIST	Fire Support Team
FO	Forward Observer
FPF	Final Protection Fire
FRAGO	Fragmentary Order
FS NCO	Fire Support Sergeant
FSO	Fire Support Officer
GR	Gunner
GS	General Support
GSR	Ground Surveillance Radar
HAW	Heavy Anti-Tank Weapon
HE	High Explosive Ammunition
HVY SEC	Heavy Tank Section (3 tanks)
ICM	Improved Conventional Munitions
INF	Infantry
LAW	Light Anti-Tank Weapon
LT SEC	Light Tank Section (2 tanks)
MAW	Medium Anti-Tank Weapon
MBA	Main Battle Area
MECH	Mechanized
MG	Machine Gun
MICV	Mechanized Infantry Combat Vehicle

MOC	Method of Control
MOE	Method of Engagement
NCS	Net Control Station
NIR	Night Infrared Device
NOD	Night Observation Device
NVD	Night Vision Device
OP	Observation Post
PL	Platoon Leader
PLT	Platoon
Plat	Platoon
RATELLO or RTO	Radio/Telephone Operator
SL	Squad Leader
SOP	Standard Operating Procedure
SP	Self-Propelled
SW	Squad Weapon
TACAIR	Tactical Close Air Support
TF	Task Force
TF CDR	Task Force Commander
TGP	Target Group
TK	Tank
TM	Team
TM CDR	Team Commander
TM LDR	Team Leader
TOW	Tube-Launched, Optically-tracked, Wire-Guided ATGM
TRP	Target Reference Point
V	Vulcan
VT	Variable Time Fuze
XO	Executive Officer
81mm	81mm Mortar (Company)
4.2"	107mm Mortar (Battalion)
155mm SP	155mm Self-Propelled Howitzer
1SG	First Sergeant

Unit Abbreviation Format Examples

(-)	Understrength
2/A/78	Second Platoon, A Company, TF 4-78
A Btry (-) (3-454) (U) (AD) (DS)	A Battery, Understrength, third of the 454th, Vulcan, Air Defense, Direct Support
A/4-78(-)	A Company, TF 4-78, Understrength
TF 9-50 FA (155,SP)	Task Force 9-50, Field Artillery (155 Howitzer equipped, Self-Propelled)

APPENDIX II

CRITICAL TASKS AND ABILITIES DEGRADED BY EACH DEBILITATING FACTOR FOR EACH UNIT/DUTY POSITION

Mechanized Infantry

Platoon Leader
Squad Leader
Maneuver Team Member
Gunner/Carrier Team Leader

Tank Crew

Platoon Leader
Commander
Gunner
Loader

FIST Personnel

FIST Chief
Forward Observer
Fire Support NCO
RATELLO (RTO)

Artillery Battery

Platoon Leader
Commander
Gunner
Loader

MECHANIZED INFANTRY-PLATOON LEADER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	60, 71, 73
	H	54, 68, 71, 73
	NF	53, 54, 56, 57, 58, 60, 61, 63, 64, 68, 69, 76
	R	53, 54, 56, 57, 58, 60, 61, 63, 64, 66, 68, 69, 72, 73, 74, 76
	PS	54, 57, 60, 69, 73
	O	50, 51, 56, 59, 60, 64, 69, 74, 75, 76
Diurnal Rhythm	NF	50, 54, 56, 60, 61, 63, 68, 69, 72
	R	50, 53, 54, 56, 57, 58, 61, 63, 64, 66, 68, 69, 72, 73, 74, 76
Light Level/Visibility	V	50, 51, 54, 57, 63, 68, 72, 74
	H	54, 63, 68, 72, 74
	DP	
	O	50, 51, 56, 59, 60, 61, 63, 64, 69, 71, 74, 75, 76
Stress	M	54, 56, 60, 63, 68, 69, 71, 72, 73
	R	53, 54, 56, 57, 58, 60, 61, 63, 64, 66, 68, 69, 72, 73, 74, 76
	PS	51, 54, 60, 69
	C	54, 55, 57, 61, 62, 63, 64, 65, 67, 68, 69, 70, 71, 72, 73, 74, 75, 76

MECHANIZED INFANTRY-SQUAD LEADER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	33, 35, 36, 37, 39, 41, 42, 44
	H	33, 39, 41, 43, 44, 47, 48
	NF	36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47, 49
	R	34, 36, 37, 38, 39, 40, 41, 42, 44, 45, 46, 47, 49
	PS	33, 39, 44
	O	35, 36, 37, 40, 41, 42, 43, 47, 49
Diurnal Rhythm	NF	36, 37, 39, 40, 41, 42, 43, 44
	R	36, 37, 39, 40, 41, 42, 43, 44, 45, 46, 47, 49
Light Level/Visibility	V	33, 35, 36, 37, 39, 41, 42, 44, 47, 48
	H	33, 39, 41, 44, 47, 48
	DP	
	O	35, 36, 37, 40, 41, 42, 43, 47, 49
Stress	M	39, 40, 43, 44, 49
	R	34, 36, 39, 40, 41, 43, 44, 45, 46, 47, 49
	PS	33, 39, 44
	C	34, 39, 40, 43, 44, 46, 47, 48, 49

MECHANIZED INFANTRY-MANEUVER TEAM MEMBER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	19, 20, 26, 28, 30, 32
	H	19, 22, 26, 30, 32
	NF	21, 25
	R	21, 25
	PS	19, 26, 28, 29, 30, 32
	O	22, 23, 24
Diurnal Rhythm	NF	21, 25
	R	21, 25
Light Level/Visibility	V	18, 19, 20, 23, 24, 26, 29, 30, 31, 32
	H	19, 22
	DP	18, 20, 22, 23, 30
	O	24, 29, 31
Stress	M	19, 22, 24, 25, 26, 28, 30, 32
	R	18, 21, 25
	PS	19, 24, 26, 28, 29, 30, 32
	C	22

MECHANIZED INFANTRY-GUNNER/CTL

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	1, 2, 3, 4, 9, 14, 16
	H	1, 6, 9, 14
	NF	10, 11, 12, 14, 16
	R	10, 11, 12, 14, 16
	PS	1, 2, 3, 6, 9, 11, 14
	O	6, 7, 11, 13, 15
Diurnal Rhythm	NF	11, 13, 14, 16
	R	11, 12, 13, 14, 16
Light Level/Visibility	V	1, 2, 3, 4, 6, 9, 11, 12, 13, 14, 16
	H	1, 2, 3, 4, 6, 12
	DP	6
	O	2, 7, 11, 13, 15
Stress	M	6, 7, 11, 12, 15
	R	10, 11, 12, 13, 14, 15, 16
	PS	1, 3, 6, 11, 14
	C	8, 12, 13

TANK PLATOON-PLATOON LEADER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	15, 21
	H	
	NF	14, 24
	R	3, 4, 5, 6, 7, 12, 13, 14, 16, 17, 18, 22, 25
	PS	15, 16, 22, 23, 24
	O	3, 4, 5, 6, 7, 12, 13, 14, 18, 23, 24
Diurnal Rhythm	NF	14, 24
	R	1, 2, 3, 4, 5, 6, 7, 12, 13, 14, 16, 17, 18, 22, 25
Light Level/Visibility	V	15, 16, 18, 19, 21, 22, 24
	H	
	DP	
	O	1, 2, 4, 14, 15, 23, 24
Stress	M	10, 14, 26
	R	1, 2, 3, 4, 5, 6, 7, 12, 13, 14, 16, 1. 22, 25
	PS	15, 24
	C	1, 2, 8, 17, 18, 23, 24, 25, 26

TANK PLATOON-TANK COMMANDER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	33, 35, 38, 40
	H	33
	NF	
	R	30, 39
	PS	35, 39, 40
	O	29, 32, 35
Diurnal Rhythm	NF	
	R	30, 39
Light Level/Visibility	V	33, 34, 35, 36, 38, 39, 40
	H	33
	DP	
	O	29, 32, 35
Stress	M	34
	R	30, 39
	PS	35
	C	27, 28, 32, 35, 37, 40, 41

TANK PLATOON-GUNNER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	42, 43, 46
	H	
	NF	
	R	
	PS	42, 43
	O	
Diurnal Rhythm	NF	
	R	
Light Level/Visibility	V	42, 43, 46
	H	
	DP	
	O	
Stress	M	
	R	
	PS	
	C	42, 43

TANK PLATOON-LOADER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	
	H	
	NF	
	R	
	PS	
	O	
Diurnal Rhythm	NF	
	R	
Light Level/Visibility	V	
	H	
	DP	
	O	
Stress	M	
	R	57
	PS	
	C	56

FIST-FIST CHIEF

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	10, 14, 15, 16, 20, 21, 23, 26
	H	
	NF	10, 14, 15, 16, 20, 21, 22, 23, 24, 25, 26
	R	3, 4, 5, 6, 11, 13, 19, 25
	PS	26
	O	5, 7, 8, 9, 10, 11, 14, 16, 20, 22, 23, 24, 26
Diurnal Rhythm	NF	10, 14, 15, 16, 20, 21, 22, 23, 24, 25, 26
	R	5, 6, 11, 13, 19, 25, 26
Light Level/Visibility	V	7, 8, 10, 11, 12, 13, 14, 15, 16, 20, 21, 22, 23, 26, 27
	H	
	DP	
	O	5, 7, 8, 9, 10, 11, 12, 14, 16, 20, 22, 23, 24, 26
Stress	M	1, 26, 27
	R	2, 5, 10, 11, 13, 14, 15, 17, 19, 20, 22, 23, 25, 26
	PS	10, 11, 14, 15, 16, 20, 21, 22, 23, 26, 27
	C	2, 3, 4, 10, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 27, 29

FIST-FORWARD OBSERVER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	39, 45, 46, 47, 48, 49, 51, 54
	H	
	NF	38, 40, 41, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54
	R	35, 42, 44, 53
	PS	39, 54
	O	35, 36, 37, 38, 39, 42, 45, 47, 48, 50, 51, 52, 54
Diurnal Rhythm	NF	38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54
	R	35, 42, 44, 53, 54
Light Level/Visibility	V	36, 37, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 54, 55
	H	
	DP	
	O	35, 36, 37, 38, 39, 42, 43, 45, 47, 48, 50, 51, 52, 54
Stress	M	30, 31, 54, 55
	R	32, 33, 35, 42, 44, 45, 46, 47, 48, 50, 51, 53, 54
	PS	39, 42, 45, 46, 47, 48, 49, 50, 51, 54, 55
	C	32, 33, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56

FIST-FIRE SUPPORT NCO

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	
	H	
	NF	
	R	
	PS	
	O	
Diurnal Rhythm	NF	
	R	
Light Level/Visibility	V	
	H	
	DP	
	O	
Stress	M	57
	R	
	PS	
	C	58

FIST-RADIO TELEPHONE OPERATOR

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V H NF R PS O	
Diurnal Rhythm	NF R	
Light Level/Visibility	V H DP O	
Stress	M R PS C	59

ARTILLERY BATTERY-EXECUTIVE OFFICER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	
	H	
	NF	2, 4, 6
	R	6,
	PS	
	O	2, 3, 4
Diurnal Rhythm	NF	2, 4
	R	
Light Level/Visibility	V	1, 2, 4, 5
	H	
	DP	
	O	2, 3, 4
Stress	M	2, 4, 6
	R	4, 5, 6
	PS	
	C	1, 3, 4

ARTILLERY BATTERY-SECTION CHIEF

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	9, 11, 16
	H	
	NF	9, 15, 16
	R	10, 17
	PS	
	O	9, 10
Diurnal Rhythm	NF	9, 11, 15, 16
	R	
Light Level/Visibility	V	7, 8, 9, 10, 11, 15, 16, 17
	H	
	DP	
	O	9, 10, 16, 17
Stress	M	
	R	8, 10, 12, 17
	PS	
	C	13, 14, 15, 17

ARTILLERY BATTERY-GUNNER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	18, 20, 21, 25, 26, 27, 28, 29, 30
	H	
	NF	18, 19, 20, 21, 22, 23, 24, 30, 34
	R	
	PS	
	O	20, 31, 32, 33, 34
Diurnal Rhythm	NF	18, 22, 23, 24, 30, 34
	R	
Light Level/Visibility	V	18, 19, 20, 22, 23, 25, 26, 27, 28, 29, 30, 32, 33
	H	
	DP	
	O	20, 25, 26, 28, 31, 32, 33, 34
Stress	M	32, 33, 34
	R	
	PS	
	C	

ARTILLERY BATTERY-CREW MEMBER

DEBILITATING FACTOR	ABILITY	TASKS
Fatigue	V	
	H	40
	NF	
	R	48
	PS	
	O	
Diurnal Rhythm	NF	
	R	
Light Level/Visibility	V	41, 42, 43, 45, 47
	H	
	DP	
	O	
Stress	M	48
	R	48
	PS	43
	C	40