U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

AD-A034 610

INITIAL VALIDATION OF REALTRAIN WITH ARMY COMBAT UNITS IN EUROPE

ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES, ARLINGTON, VIRGINIA

OCTOBER 1976

024105

Research Report 1191

AD

ADA034610

INITIAL VALIDATION OF REALTRAIN WITH ARMY COMBAT UNITS IN EUROPE

UNIT TRAINING AND EVALUATION SYSTEMS TECHNICAL AREA



DDC
RECEIVED
JAN 21 1977
D

U. S. Army

Research Institute for the Behavioral and Social Sciences

October 1976

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

Approved for public release; distribution unlimited.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Research Report 1191	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* INITIAL VALIDATION OF REALTRAIN WITH ARMY COMBAT UNITS IN EUROPE		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) R. T. Root, K. I. Epstein, F. H. Steinheiser, J. F. Hayes, S. E. Wood, R. H. Sulzen, G. G. Burgess, A. Mirabella, D. E. Erwin, E. Johnson III		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Army Research Institute for the Behavioral and Social Sciences 1300 Wilson Blvd, Arlington, VA 22209		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS 2Q763731A773
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Training and Doctrine Command (TRADOC) Fort Monroe, VA 23351		12. REPORT DATE October 1976 13. NUMBER OF PAGES 136
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		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)*

Small unit training	REALTRAIN
Tactical training	Performance-oriented training
Engagement simulation	Unit performance evaluation
Simulation techniques	

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

This report documents the results of an analysis of data collected during the implementation of a new method for small unit tactical training, known as REALTRAIN. The study was designed to measure the training effectiveness of the REALTRAIN method; to identify needs to refine REALTRAIN training techniques; and to assess the methodology used for unit evaluation.

REALTRAIN exercises employ combat techniques to simulate weapons effects and weapons signatures. The REALTRAIN method provides a working context for

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

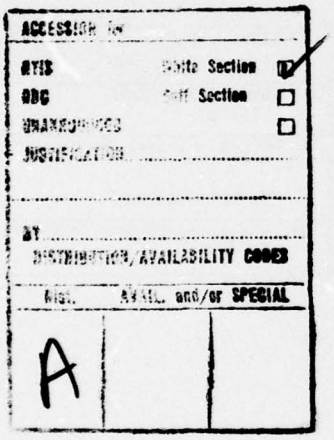
Unclassified

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

20. the learning of tactical skills by armor, infantry, and anti-armor personnel in a combined arms environment.

The REALTRAIN training method was implemented by a TRADOC Mobile Training Team (MTT) during the period 3 November 1975 to 5 March 1976 at four divisional training sites throughout the U.S. Army, Europe (USAREUR). Cadres from each USAREUR infantry and armor battalion were trained in REALTRAIN controller functions so that they could conduct REALTRAIN exercises in their own units. Other USAREUR infantry and armor personnel served in the practice exercises as "player" participants.

REALTRAIN implementation in USAREUR provided a valuable empirical base and data source for the analysis of: (1) tactical performance by participants in the exercises; (2) participant and controller reactions to this new method; and (3) the cost of conducting such exercises.



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

J. E. UHLANER
Technical Director

W. C. MAUS
COL, GS
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-P, 1300 Wilson Boulevard, Arlington, Virginia 22209.

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.

Research Report 1191

INITIAL VALIDATION OF REALTRAIN WITH ARMY COMBAT UNITS IN EUROPE

R. T. Root, K. I. Epstein, F. H. Steinheiser, J. F. Hayes,
S. E. Wood, R. H. Sulzen, G. G. Burgess,
A. Mirabella, D. E. Erwin, and E. Johnson III

Submitted by:
Frank J. Harris, Chief
UNIT TRAINING AND EVALUATION SYSTEMS TECHNICAL AREA

Approved By:

Joseph Zeidner, Director
ORGANIZATIONS AND SYSTEMS
RESEARCH LABORATORY

J. E. Uhlaner
TECHNICAL DIRECTOR

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

Office, Deputy Chief of Staff for Personnel
Department of the Army
1300 Wilson Boulevard, Arlington, Virginia 22209

DDC
RECEIVED
JAN 21 1977
D

October 1976

Army Project Number
2Q763731A773

Combat Training Techniques

IV

Approved for public release; distribution unlimited

FOREWORD

The research reported here is part of a broader program on combat unit training being conducted by the Unit Training and Evaluation Systems Technical Area of the Army Research Institute for the Behavioral and Social Sciences (ARI). Since 1972 ARI has conducted research on the development and evaluation of new training techniques, particularly crew training and tactical training in the unit context. The Army Training and Doctrine Command (TRADOC) has identified small unit tactical engagement simulation training as its highest behavioral science research priority. ARI developed a tactical engagement simulation training method known as REALTRAIN which provides extremely realistic and motivating training for small combat arms units. Simple but effective casualty assessment techniques are used in REALTRAIN to conduct engagement simulation training up to the reinforced platoon level.

This report documents the results of the analysis of data collected during the conduct of REALTRAIN exercises as implemented by a TRADOC Mobile Training Team (MTT) during the period 3 November 1975 - 5 March 1976 for infantry and armor battalions at four divisional training sites throughout the U.S. Army, Europe (USAREUR). Personnel of the ARI Field Unit, Heidelberg, who assisted the research team were: T. G. Ryan, C. J. Consentino, L. G. Yates of ARI; G. E. Manthey, W. A. Buxton, and H. L. Moon of General Research Corporation. Special thanks are due to members of the TRADOC Mobile Training Team for supporting the research team: MAJ L. M. Jackson, Armor School; MAJ R. N. Leary, Infantry School; MAJ D. M. Hooper, Artillery School; MAJ L. E. Word, ARI; CPT A. A. Severino, CATB; CPT G. W. Heckman, Infantry School; and SGT B. A. Lamb, CATB. MAJ Word played a special role in that he was an active participant in planning the research effort, as well as a member of the MTT. MAJ R. K. Traub, USAR, assisted in analyzing and interpreting selected data of the report. Both LTC J. L. Madden, formerly Program Manager for Engagement Simulation, and LTC G. J. Stapleton, present Manager, provided welcome support and encouragement.

The entire program is responsive to the requirements of RDTE Project 2Q763731A773 and the Program Manager for Tactical Engagement Simulation Systems of the Training Device Directorate, Training Support Center TRADOC at Fort Eustis, Virginia (formerly of the Combat Arms Training Board at Fort Benning, Georgia).



J. E. UHLANER
Technical Director

INITIAL VALIDATION OF REALTRAIN WITH ARMY COMBAT UNITS IN EUROPE

BRIEF

A team from the Army Research Institute accompanied the TRADOC Mobile Training Team (MTT) implementing the REALTRAIN training method in USAREUR. Training was conducted for three weeks at each of four divisional training areas over the 3 November 1975 to 5 March 1976 period. About 395 cadre personnel were trained as controllers, with 542 armor and infantry personnel serving as participants.

Using nineteen collection forms, the research team gathered data on the training effectiveness of REALTRAIN, ways of improving REALTRAIN, and better methodology to assess unit tactical performance.

Participant players at each site were organized into A and B Teams. A Teams conducted REALTRAIN exercises for three weeks; B Teams rotated every week. Although many factors were against conducting a clear cut experiment, the hypothesis was that the tactical performance of the A Teams would improve over the three-week training period.

Exercises were two basic types: meeting engagements (N = 33) and attack/defense(delay) (N = 26). The force ratio was 1:1 in all exercises. A tank platoon, two infantry squads and a TOW section were on each side. Although tactically unrealistic, the attackers' force ratio reflects the primary mission of the MTT: to maximize cadre training effectiveness, rather than to measure REALTRAIN. As a result, effectiveness data from meeting engagements provide more reasonable REALTRAIN performance estimates than data from attack/defense exercises.

Training effectiveness results are impressively positive and consistent: A Teams won 16 meeting engagements; B Teams won 4; 13 resulted in ties. Casualty results show that in Week 3 across all sites the vehicle casualty ratio (vehicles killed/vehicles played) was .36 for A Teams, .52 for B Teams; personnel casualty ratios were similar. As measured by a Weighted Casualty Index (WCI), the performance difference in favor of A Teams in Week 3 was statistically significant. The difference between A Team performance for Weeks 1 and 3 was also statistically significant. B Teams showed no significant difference in performance between Weeks 1 and 3.

Interviews and questionnaires from controllers and participants also reflect a very favorable, even enthusiastic, attitude toward REALTRAIN effectiveness. Participants and controller trainees alike reacted enthusiastically to the REALTRAIN program, citing its realism and the learning opportunities in combined arms operations, cross-training, development of battlefield confidence, and teamwork in tactical maneuvers.

Overall results on weapons effects show:

41% of the tanks played were killed, mostly by other tanks;
43% of the infantry were killed, mainly by small arms;
39% of TOWs were destroyed, mostly by artillery and other TOWs;
51% of the APCs were killed, mostly by artillery and tanks.

Data suggest means of refining and improving REALTRAIN, especially in the After Action Review.

INITIAL VALIDATION OF REALTRAIN WITH ARMY COMBAT UNITS IN EUROPE

CONTENTS

INTRODUCTION xiii

OBJECTIVES xiii

BACKGROUND xiii

METHOD xv

RESULTS xvi

TECHNICAL SUPPLEMENT

INTRODUCTION 1

BACKGROUND 1

METHOD 4

RESEARCH ENVIRONMENT OVERVIEW

Mobile Training Team (MTT) Mission 4
Training Sites 5
REALTRAIN Controller Training Schedule 6
Research Design 6
Typical REALTRAIN Exercise 7

DATA COLLECTION

Direct Measures of Tactical Performance 8
Indirect Measures 9
Logistic (Cost) Data 10
Refinement Data 10

RESULTS

FACTORS IN INTERPRETING RESULTS 10

OBJECTIVE RESULTS 12

Summary of REALTRAIN Exercise Results 12
Training Effectiveness Results 15
Weapons Effectiveness Data 42
Unit Evaluation Analysis 48

SUBJECTIVE DATA RESULTS

Participant Questionnaire 51
Leader-Controller Questionnaire 53
Summary of Participant Interviews 60

LOGISTICAL DATA

Vehicle Data 64
Ammunition Expenditure Data 66

OBSERVATIONS ON REFINING REALTRAIN

Planning Training to Overcome Observed Performance Deficiencies 69
Terminating an Exercise 70
Controller Debriefing 71
Net Control Procedures 71
After Action Review 71

APPENDIXES 73

DISTRIBUTION 116

LIST OF TABLES

1. Description of Training Sites 5

2. REALTRAIN Controller Training Schedule 6

3. Number and Type of Exercise by Site 13

4. Meeting Engagement Outcomes by Team and Week of Training 14

5. Outcomes for Attacker In Attack/Defense Exercises by Week of Training 14

6. Comparison of Tank Casualties for Team A and Team B Meeting Engagements 15

7. Comparison of Infantry Casualties (By Percentage Lost) for Team A and Team B Meeting Engagements 16

8. Comparison of APC Casualties (By Percentage Lost) for Team A and Team B Meeting Engagements 17

9. Comparison of TOW Casualties (By Percentage Lost) for Team A and Team B Meeting Engagements 18

10. Comparison of Team A and Team B Performance for Weeks 1 and 3 (Meeting Engagements) 19

11. Comparison of Tank Casualties (By Percentage Lost) for Team A and Team B, Attack/Defense 20

12. Comparison of Infantry Casualties (By Percentage Lost) for Team A and Team B, Attack/Defense 20

13. Comparison of APC Casualties (By Percentage Lost) for Team A and Team B, Attack/Defense 21

14. Comparison of TOW Casualties (By Percentage Lost) for Team A and Team B, Attack/Defense 21

15. Average WCI for All Exercises by Weeks 26

16. Percent of Exercise Duration before "X"% Casualties Incurred 28

17. Portion of Exercise Duration before Tanks (TK) and TOWs (TW) Are Destroyed 29

18. Indirect Fire Analysis All Sites: Meeting Engagement by Week 31

19. Indirect Fire Analysis All Sites: Team A Attack by Week 31

20. Indirect Fire Analysis All Sites: Team B Attack by Week 32

21. Indirect Fire Analysis All Sites: All Exercises by Week 32

22. Communication Indices, Casualty Rates, and Estimated Outcome for Meeting Engagements Only 35

23. Communication Rates before and after Casualties, and Casualty Rates for Meeting Engagements Only 38

24. Team Making Initial Detection and Initial Engagement by Training Week (Meeting Engagements) 39

25. Initial Detector or Engager as a Function of Mission in Attack/Defend Exercises 40

26. Initial Detection and Initial Engagement (in Minutes after Start and Range) by Team as a Function of Training Week: Meeting Engagements 41

27. Weapon Inflicting First Casualty by Site (Total N = 59) . . . 42

28. Tank Losses as Function of Weapon Type 44

29. Infantry Losses as Function of Weapon Type 44

30. TOW Losses as Function of Weapon Type 45

31. APC Losses as Function of Weapon Type 45

32. Number of Agreements (Out of 14 Exercises) Between Performance Ratings and Casualty Data 50

33. Comparison of REALTRAIN to Other Methods of Collective Training 53

34. Comparison of REALTRAIN to Live Fire Exercises by Branch 54

35. Percent of Time Recommended to be Devoted to Each Training Method 54

36. Effectiveness of REALTRAIN for Tactical Training 55

37. Extent of Prior Tactical Training 55

38. Constraints to Tactical Training 56

39. Tactical Training Value of REALTRAIN Exercises for Controllers 59

40. Adequacy of REALTRAIN Controller Training 59

41. SCOPES utilization 60

42. Average Miles Traveled/Engine Hours by Type of Vehicle, Per Week, and Site 65

43. Actual Ammunition Expended (On a Per Exercise Basis) During REALTRAIN Implementation in USAREUR 67

44. Estimated Ammunition Requirements for REALTRAIN 68

LIST OF FIGURES

1. Weighted Casualty Index (WCI) for Team A and Team B Attacks . . 23

2. Differences in Weighted Casualty Index (WCI) as a Function of Week of Training 24

3. Average Weighted Casualty Index (WCI) for All Exercises by Weeks 25

4. Vehicle Casualties, Cumulative Personnel Casualties, and, Communication Rate as a Function of Exercise Duration 36

5. Percent of Tank Casualties as a Function of Weapon Type 46

6. Percent of Infantry Casualties as a Function of Weapon Type 46

7. Percent of TOW Casualties as a Function of Weapon Type 47

8. Percent of APC Casualties as a Function of Weapon Type 47

9. Perceived State of Training Before and After REALTRAIN 52

10. "Military Skills Imparted to Participants by REALTRAIN": Three Responses Most Frequently Given by Controllers and Leaders 57

11. "Military Skills Imparted to Controllers by REALTRAIN": Three Responses Most Frequently Given by Controllers 58

INITIAL VALIDATION OF REALTRAIN WITH ARMY COMBAT UNITS IN EUROPE

INTRODUCTION

This report documents the results of the analysis of data collected during the conduct of REALTRAIN, a new method for small unit combined arms tactical training. The REALTRAIN training method was implemented by a TRADOC Mobile Training Team (MTT) during the period 3 Nov 1975 - 5 Mar 1976 for infantry and armor battalions at four divisional training sites throughout the U.S. Army, Europe (USAREUR).

REALTRAIN exercises employ realistic combat engagement techniques for simulating weapons effects and weapons signatures. REALTRAIN training provides for the learning of tactical skills by armor, infantry, and anti-armor personnel in a combined arms environment.

REALTRAIN implementation in USAREUR provided valuable research data for the evaluation of: (1) tactical performance by participants in the exercises; (2) "player" and controller reactions to this new method; and (3) the cost of conducting such exercises.

OBJECTIVES

The study had three broad research objectives:

(1) To measure the training effectiveness of the REALTRAIN method,

(2) To identify needs to refine REALTRAIN training techniques, and

(3) To assess the methodology used for unit evaluation.

BACKGROUND

The objective of small unit tactical training is to provide combat units with the skills required to fight and survive on the modern battlefield, which involves the violent interaction of two mobile opposing forces who are out to destroy one another. Tactical training seeks to represent this combat environment as realistically as possible.

Traditional tactical field exercises have taken two forms: (1) the firing of live ammunition at targets which can neither fire back nor hide or protect themselves; and (2) blank fire exercises between opposing

forces where the effectiveness of the fire is left to the subjective judgment of the umpires. Both exercises have a chief shortcoming in their inability to realistically simulate actual combat.

The REALTRAIN system effectively overcomes the shortcomings of both live and blank fire training by means of engagement simulation techniques. "Engagement simulation" techniques permit the conduct of two-sided, free-play exercises within a tactical environment where it would be appropriate for two opposing forces to come into contact. The important additional ingredient is a realistic method for casualty assessment.

The learning benefits during REALTRAIN training occur in three general ways:

(1) trial-and-error "discovery" by an individual while taking part in the exercise;

(2) feedback from the other participants during the After Action Review; and

(3) remedial training to overcome observed deficiencies in individual or team skills.

These essential training functions are encompassed in the three steps of engagement simulation training:

Step 1. Each weapon is equipped with a device that realistically simulates its casualty-producing capability in combat. Two opposing forces then conduct a free-play tactical exercise, enabling the battle to unfold as it would on an actual battlefield. The simulation devices provide immediate, reliable feedback to each soldier concerning his actions. If he uses proper techniques and tactics in each situation, he is more likely to remain alive; if not, he is more likely to be killed.

Step 2. At the completion of the tactical exercise, both forces are brought together for a detailed After Action Review. Each soldier who has killed another soldier explains in detail how he was able to detect, engage, and kill him. Techniques and tactics to enable soldiers to keep from being killed are likewise discussed.

Step 3. Successive repetitions of engagement simulation and After Action Reviews are conducted. The soldiers are able to reinforce their new skills, make new mistakes, and gain additional skills.

The fundamental principles guiding the development of "engagement simulation" techniques such as REALTRAIN have been:

(1) that they must promote learning skills applicable in actual combat, not just provide physical fidelity;

(2) that the simulated combat environment must be credible to the participants;

(3) that training costs and equipment complexity must be kept to a minimum;

(4) that all unit personnel must perform functions that closely parallel their actual jobs; and

(5) that the simulated effects of weapons must approximate their actual effects.

METHOD

Training was conducted for three weeks at each of four divisional training sites in USAREUR, which varied in size, terrain, and openness. Participant players were organized into A Teams and B Teams. In general, the A Teams conducted REALTRAIN exercises for three weeks; B Teams were rotated every week. Thus, each A Team faced new and inexperienced opponents for the second and third weeks at each site. Conversely, each B Team faced an experienced opponent except for the first week at each site, when both teams were new.

Two types of two-sided, free-play exercises were conducted:

(1) meeting engagements; and

(2) attack/defense (delay).

The typical REALTRAIN exercise occurs in the following sequence:

1. Boundaries are established by the senior controllers.

2. Each team is briefed on the hypothetical enemy situation and given its specific mission.

3. Each team is allowed one hour to develop its tactical plan, and then brief it to the team's senior controller.

4. During the exercise itself (which usually lasts from 1 1/2 to 2 hours), a record is kept of casualties and how they were inflicted.

5. After the exercise, controllers are assembled to verify casualties and resolve any differences.

6. One of the senior controllers conducts an After Action Review, with all of the participants from both teams present.

To meet the research objectives, data collection instruments were developed, pretested, and revised. The data collected were of four general types:

(1) Direct measures (both objective and subjective) of tactical performance: training and weapon effectiveness;

(2) Indirect measures (attitudinal and opinion) of the use of the REALTRAIN method of tactical training for both participants and student controllers;

(3) Cost data on the conduct of REALTRAIN exercises (ammunition and vehicle usage);

(4) Data to help refine the REALTRAIN method.

Among direct measures, the Exercise Diagram with the Exercise Narrative provided an overall description of the simulated battle. Other forms in this category focused upon specific aspects of tactical performance. The Net Control Sheet, for example, provided a chronological casualty event record necessary for the conduct of an After Action Review (and served as a major source of research data).

Indirect measures such as the Participant Questionnaire and the Leader/Controller Questionnaire were used to obtain opinions about the effectiveness of REALTRAIN and its methods from the participants, team leaders, and student controllers.

Logistic (cost) data, needed to provide a basis for estimating the cost of conducting REALTRAIN engagements, were obtained on forms such as the Ammunition Usage Tabulation Sheet.

Refinement data on the REALTRAIN methodology were obtained by research personnel primarily from the After Action Review Record.

In general, the data collection effort was extremely successful. The Exercise Diagram and the associated Exercise Narrative were found to be of great value as a simple method for recording exactly what happened during an exercise for later analysis.

RESULTS

The primary mission of the MTT was to maximize the training of cadre rather than to measure the effectiveness of REALTRAIN. This and other important factors had a potential influence on the results of the study:

(1) To insure maximum exposure to training, MTT personnel sometimes intervened during an exercise or allowed exercises to continue beyond the point where a prudent commander would withdraw.

(2) In all exercises, the ratio of opposing forces was 1:1 with a tank platoon, two infantry squads, and a TOW section on each side. This ratio is appropriate for meeting engagements, but presents unrealistic odds against an attacking unit in an attack/defense exercise.

(3) Inferences from the data must consider factors such as the limited sample size, the differences among training sites, and variations among crews and teams in experience prior to the exercises.

(4) The "Win-Loss-Tie" judgments of battle results were clearly subjective, since other factors besides personnel and vehicle casualties had to be weighed (mission accomplishment, elapsed time, terrain, weather, artillery rounds available, capability to continue).

A total of 59 exercises were conducted during the REALTRAIN implementation in USAREUR. Of these, 33 were meeting engagements and 26 were attack/defense (delay) exercises.

For meeting engagements the A Teams tended to win more exercises than the B Teams during the second and third weeks. During the first week, A Teams won three engagements, B Teams three engagements, and four were considered ties. For Weeks 2 and 3 combined, A Teams won 10 meeting engagements, B Teams won none, and nine resulted in ties. In attack missions, where the attacker is at a disadvantage when meeting a force of equal size, A Teams in the attack actually won one attack/defense exercise in Week 2 and two in Week 3 (Team B won none).

With increased tactical proficiency through REALTRAIN, a combat unit should reduce the number of casualties it incurs (e.g., by proper use of cover and concealment and proper movement techniques) while at the same time increasing the number of casualties it inflicts (e.g., by more effective employment of available weapons).

In meeting engagements, both teams sustained approximately the same proportion of tank casualties during the first week (Team A: 48%, Team B: 45%). From Week 1 to Week 3, however, Team A reduced its casualties by 26% while Team B's casualties increased by 49%. Team A infantry casualties decreased 13% from Week 1 to Week 3 while Team B casualties increased by 11%. Both teams decreased the number of APC casualties during the third week, 42% for Team A and 27% for Team B. In TOW casualties, Team A showed a 64% decrease while Team B showed a 51% decrease.

As measured by a Weighted Casualty Index (WCI), the difference between the teams at Week 1 and Week 3 during attack/defense (delay) exercises were likewise in favor of the A Teams. Team A on the attack

reduced its losses relative to Team B by 32%. Team B on the attack, however, increased its losses by 11% while those of Team A decreased by 18%.

For all exercises, the WCI indicates the difference between A Teams and B Teams for Week 3 was significant at the .05 level of significance in favor of A and the difference between A Teams at Week 1 and A Teams at Week 3 was significant at the .01 level of significance in favor of Week 3. By contrast, B Teams showed no difference between Weeks 1 and 3.

Appropriate statistical analyses of meeting engagements indicated that there were no differences between A and B Teams in the rate of personnel casualties or vehicle losses by one team as a function of the duration of the exercise.

For indirect fire effectiveness, overall, Team A inflicted more casualties (A: 356, B: 295) with fewer rounds (A: 1004, B:2200), resulting in a higher efficiency value.

A Communication Index (CI) was calculated to reflect the extent to which each team's radios were used during the exercise. No conclusive association was indicated between the rate at which A or B Teams used their radios and the rate at which they incurred casualties or the estimated outcome of the exercise provided by the MTT.

In terms of initial detection and initial engagement, the data indicate that for meeting engagements the frequency with which Team A first detected and engaged Team B tended to increase with training. During the first week, the two teams are relatively equal (initial detector A: 5, B: 5; initial engager A: 6, B: 4). For Weeks 2 and 3, however, Team A detected and engaged first more than twice as often as Team B, giving Team A a total two-to-one advantage over four sites and the three training weeks (initial detector A: 17, B: 11, initial engager A: 21, B: 8).

Overall results with respect to weapons effectiveness show that 41% of all tanks played were killed, mostly by other tanks; 43% of infantry were killed, mainly by small arms; 39% of TOW's were destroyed by artillery and other TOW's primarily; and 51% of the APC's were killed, mostly by artillery and tanks.

In conjunction with the REALTRAIN exercises, a Participant Questionnaire was completed by 542 participants: 302 with an infantry MOS (56%) and 240 with an armor MOS (44%). They felt that REALTRAIN, compared to normal unit training, was "much more effective," 63%; "more effective," 21%; "equal," 10%; and "less effective," 5%.

A Leader-Controller Questionnaire was administered to 343 controllers and 38 leaders (squad and platoon NCO's and officers) ranging in

grades from E-4 to O-3. Responses were typically quite favorable to REALTRAIN. Compared to other exercises, REALTRAIN was reported by 77% as more effective than live fire, by 97% as more effective than field exercises, and by 94% as more effective than battle drill.

For specific tactical training, REALTRAIN was considered "very effective" by 90% of the respondents in use of terrain for cover and concealment, by 72% in employment of indirect fire, and by 73% in employment of all available weapons. Almost all controllers (99%) felt adequately prepared by their week of training to implement REALTRAIN in their unit.

Subjective data represented by interviews conducted by the research team reflect a very favorable and even enthusiastic attitude toward REALTRAIN effectiveness on the part of controller trainees and participants alike. Interviewee responses strongly support the data generated in the Participant and Leader/Controller Questionnaires regarding the benefits of REALTRAIN as a learning experience.

REALTRAIN was felt to be superior to all other types of training for teaching individual battlefield skills and the need for teamwork to accomplish a unit's mission, and more relevant to an expected combat situation than other kinds of tactical training.

The data collected during the REALTRAIN/USAREUR implementation resulted in suggestions for further refinement and improvement of REALTRAIN methodology, particularly with respect to the After Action Review.

TECHNICAL SUPPLEMENT

INTRODUCTION

This report documents the results of an analysis of data collected during the implementation of a new method for small unit tactical training, known as REALTRAIN.

The study had three broad research objectives:

(1) To measure the training effectiveness of the REALTRAIN method;

(2) To identify needs to refine REALTRAIN training techniques; and

(3) To assess the methodology used for unit evaluation.

REALTRAIN exercises employ combat engagement techniques to simulate weapons effects and weapons signatures. The REALTRAIN method provides a working context for the learning of tactical skills by armor, infantry, and anti-armor personnel in a combined arms environment.

The REALTRAIN training method was implemented by a TRADOC Mobile Training Team (MTT) during the period 3 November 1975 to 5 March 1976 at four divisional training sites throughout the U.S. Army, Europe (USAREUR). Cadres from each USAREUR infantry and armor battalion were trained in REALTRAIN controller functions so that they could conduct REALTRAIN exercises in their own units. Other USAREUR infantry and armor personnel served in the practice exercises as "player" participants.

REALTRAIN implementation in USAREUR provided a valuable empirical base and data source for the analysis of: (1) tactical performance by participants in the exercises; (2) participant and controller reactions to this new method; and (3) the cost of conducting such exercises.

BACKGROUND

The objective of small unit tactical training is to provide combat units with skills required to fight and survive on the modern battlefield. The combat environment, which involves the violent interaction of two mobile opposing forces who are out to destroy one another, is difficult to simulate. Tactical training seeks to represent combat conditions as realistically as possible.

Before 1974, traditional tactical field exercises had taken two forms: (1) the firing of live ammunition at immobile targets which can neither fire back nor hide or protect themselves; and (2) blank

fire exercises between opposing forces where the effectiveness of the fire is left to the subjective judgment of the umpires.

Both exercises have a chief shortcoming in their inability to realistically simulate actual combat. Live fire exercises bear only a slight resemblance to combat, in that the immobile targets simply cannot perform the function of a skilled and determined enemy. The effectiveness of live fire exercises may also be overestimated because the simple realism of battle sounds may suggest that other combat aspects are being realistically simulated as well.

Blank fire exercises, unlike live fire, have the decided advantage of permitting two opposing forces to attack each other. While the blank rounds realistically simulate the act of firing, however, they provide no reliable feedback to the participant on the effectiveness of his fire. Only an overall subjective judgment can be made by the personnel umpiring the exercise.

As a result of TRADOC-sponsored major research in combat unit training by the Army Research Institute for the Behavioral and Social Sciences (ARI), the Army recently adopted and is implementing worldwide a new combat training technique for combined arms tactical training, known as REALTRAIN. (An earlier version, SCOPES, was developed for infantry unit training.)

The REALTRAIN system effectively overcomes the shortcomings of both live and blank fire training by means of engagement simulation techniques. "Engagement simulation" techniques permit the conduct of two-sided, free-play exercises within a tactical environment where it would be appropriate for two opposing forces to come into contact. The important additional ingredient is a realistic method for casualty assessment.

The fundamental principles guiding the development of "engagement simulation" techniques such as REALTRAIN have been:

(1) that they must promote learning of skills applicable in actual combat, not just provide physical fidelity;

(2) that the simulated combat environment must be credible to the participants;

(3) that training costs and equipment complexity must be kept to a minimum;

(4) that all unit personnel must perform functions that closely parallel their actual jobs;

(5) that the simulated effects of weapons must approximate their actual effects.

Engagement simulation was developed to provide combat units with the realistic experience of firing and moving against an intelligent enemy who fires back, and trying to neutralize or avoid the enemy's fire.

The learning benefits during REALTRAIN training occur in three general ways:

(1) trial-and-error "discovery" by an individual while taking part in the exercise;

(2) feedback from the other participants during the After Action Review;

(3) remedial training to overcome observed deficiencies in individual or team skills.

These essential training functions are encompassed in the three steps of engagement simulation.

The first step has each soldier's and crew's weapon equipped with a device that realistically simulates its casualty-producing capability in combat. The two opposing forces then conduct a free-play tactical exercise, enabling the battle to unfold as it would on an actual battlefield. The simulation devices provide immediate, reliable feedback to each soldier concerning his actions. For example, when a soldier is "hit" by simulated enemy fire, he is so informed. If he uses proper techniques and tactics in each situation, he remains alive. This immediate feedback is essential for an effective training system.

The second step begins at the completion of the two-sided, free-play tactical exercise, when both forces are brought together for a detailed After Action Review. Each soldier who has "killed" another soldier then explains in detail how he was able to detect, engage, and "kill" the enemy soldier. This is followed by discussing how the "killed" soldier might have prevented being hit. In this way, the techniques and tactics enabling soldiers to kill other soldiers, and those techniques to keep from being killed, are identified and discussed. Unlike traditional critiques where the officer or NCO in charge lectures soldiers on mistakes observed, After Action Reviews attempt to get all soldiers to participate directly by relating their experiences and getting involved in the learning process. The officer or NCOIC facilitates the discussion and summarizes key points.

The third step consists of successive repetitions of two-sided, free-play tactical exercises and After Action Reviews. During this step, soldiers have an opportunity to use and reinforce their new skills, reduce tactical mistakes, and gain additional skills by realistic practice. Repeating the same type of tactical exercise is essential in engagement simulation training. The techniques and tactics required to

fight successfully and survive on the battlefield cannot be mastered in one or two exercises.

In simulating combat operations REALTRAIN has incorporated a wide range of weapons (M16 rifle, anti-tank weapons, mines, machine gun, artillery, tank main gun, and grenades) and led to the development of casualty assessment techniques for these weapon systems. Training Circular 71-5, REALTRAIN, describes these techniques for combined arms training. ARI Technical Report S-4, REALTRAIN: A New Method for Tactical Training of Small Units, documents the rationale, methodology, underlying principles, and the development of the REALTRAIN method.

METHOD

RESEARCH ENVIRONMENT OVERVIEW

Implementation of the REALTRAIN method in USAREUR gave the research team the opportunity to collect data which could be used to improve tactical training and evaluation techniques in an engagement simulation context. Research was secondary, however, to the mission of the Mobile Training Team (MTT).

Variables with potential to influence performance could not be controlled. For example, although attacking an enemy position with a 1:1 force ratio is unrealistic from a military point of view, it provides adequate training to student REALTRAIN controllers in attack/defense exercises. To change force ratio would have been impractical and compounded the evaluation problem even more.

Regardless of this less-than-optimal research environment, data could be collected to meet the research objectives. The next subsections describe the environment so that the reader may better understand the results presented in the next section.

Mobile Training Team (MTT) Mission

The primary mission of the MTT was to train student controllers to properly conduct REALTRAIN exercises. The "hands-on" controller training included specific objectives to train battalion cadre how to establish the mission objectives and boundaries for a REALTRAIN exercise; how to conduct the actual exercise (paying particular attention to validly assessing casualties); and how to conduct an interesting and informative After Action Review.

Training Sites

Training was conducted for three weeks at each of four divisional training sites in USAREUR, which varied considerably in size, terrain, and openness. Personnel trained at each site were from a different infantry or armor division. Table 1 covers relevant features of each area.

Table 1

DESCRIPTION OF TRAINING SITES

Site	Type of Area	Size	Terrain	Openness
I	Local Training Area (LTA)	Small	Flat, with one dominant hill	Heavily wooded
II	Major Training Area	Large	Rolling	Open
III	LTA	Medium	Rolling	Sparsely wooded
IV	LTA	Small	Rolling	Wooded, except for one large open area, 500 x 1000 m.

Site I had maximum dimensions of 1,500 x 1,000 meters, although the average exercise lane was about 1,200 x 800 meters. It was mostly flat, with one dominant hill. Topographical continuity was broken by having a track park and skeet shooting range close to the center of the area, thus precluding the use of this region for an exercise.

Site II was about 3,000 x 3,000 meters in its largest extent, and composed of open and rolling terrain. The ridgelines could be used for cover and to conceal movement, as could several treelines and wooded areas within the area itself. A large section of the northeast corner of the area was densely wooded, and was therefore used minimally for vehicle movement throughout the entire three weeks of training.

Site III had a northern boundary about 2,000 meters in length, a western boundary of 3,000 meters, a southern boundary of 800 meters, and a diagonal boundary running from northeast to southwest of about 3,300 meters. There were numerous tank trails through the rolling terrain, with ridgelines that provided cover and concealed vehicle movement. Several woodline and wooded areas also offered cover throughout the

southern sector. Several large low-lying areas could not be used because of mud. Although a local training area, the site was large enough to provide an interesting variety of exercise lanes.

Site IV was about 2,300 meters along an east-west axis and 2,100 meters along a north-south axis. The center of the area was mostly open, rather flat, with only one ridgeline adequate to conceal vehicle movement. Within this open area, there was a wooded area, about 100 x 125 meters, providing foliage cover. The eastern and western boundaries were heavily wooded.

REALTRAIN Controller Training Schedule

The typical weekly training schedule for student controllers is summarized by the following table:

Table 2

REALTRAIN CONTROLLER TRAINING SCHEDULE

	Monday	Tuesday	Wednesday	Thursday	Friday
AM	REALTRAIN Intro., Controller Duties	Control Procedures, Practical Exercise	Duties of Sr. Controller, Indirect Fire, After Action Review, Combined Arms Exercise	Combined Arms Exercise	Combined Arms Exercise
PM	Rules of Engagement, Practical Exercise	Practical Exercise	Combined Arms Exercise	Combined Arms Exercise	Graduation

The REALTRAIN Program of Instruction (POI) prepared by the MTT to implement training is presented in Appendix A.

Research Design

Participant players were organized into A Teams and B Teams. "Team A" remained for three weeks (at three of the four sites), four weeks at Site IV. A new "Team B" appeared each week at the sites except at Site IV, where the third B Team stayed for two weeks.

Thus, each A Team faced new and inexperienced opponents for the second and third weeks at each site. Conversely, each B Team faced an experienced opponent, except for the first week at each site, when both teams were new.

This design to vary the practice received by the opponent was used to evaluate the effectiveness of REALTRAIN as a tactical training procedure for combined arms elements. Specific questions that could be studied employing this type of design include:

(1) To what extent does performance improve with increased tactical training?

(2) What are the principal causes of personnel and equipment casualties?

The magnitude of effects and changes from REALTRAIN experience could be compared for two different exposure durations to REALTRAIN. For example, one might hypothesize that A Teams would improve in tactical performance more than B Teams. How much would tactical performance improve as a result of the extra two weeks of participation?

Two types of exercises were conducted: meeting engagements and attack/defense (delay). Each exercise was two-sided, free-play. The senior controller for each team did not interfere with the tactics employed by his team, except to make sure that all were within the established boundaries and that his team would contact with elements of the opposing team.

Typical REALTRAIN Exercise

The following is a typical sequence of events for a REALTRAIN exercise:

(1) Boundaries are established by the senior controllers.

(2) Each team is briefed on the hypothetical enemy situation and given its specific mission.

(3) Each team is given about one hour to develop its tactical plan, which is then briefed to the team's senior controller.

(4) During the exercise itself (which usually lasts from 1 1/2 to 2 hours), a record is kept of casualties and how they were inflicted.

(5) After the exercise, the controllers are assembled to verify the casualties and resolve any differences.

(6) One of the senior controllers conducts an After Action Review with all of the participants from both teams. All events and casualties are carefully reviewed. Participants who were "killed," or whose vehicles were destroyed, are asked what they were doing and their location when they became a casualty. Then they are asked what they would do differently the next time. Persons who made successful "kills" detail the significant events leading to the event.

DATA COLLECTION

To meet the research objectives, 19 collection instruments were developed, pretested, and revised. The data collected were of four general types:

- Direct measures of tactical performance, looking at both training and relative weapon effectiveness. These measures were both objective and subjective.

- Indirect measures such as attitudinal and opinion data on using the REALTRAIN method from both participants and student controllers.

- Cost data on REALTRAIN exercises--ammunition expenditure and vehicle usage.

- Data to help refine the REALTRAIN method.

A Data Collection Scheme (which lists the data collection instruments developed for this research, procedures, nature of data, and objectives) is in Appendix B.

Direct Measures of Tactical Performance

Among direct measures, the data collection effort provided three major kinds of information: (1) description of the unfolding tactical events, i.e., what happened, when, and where; (2) casualty assessment; and (3) subjective judgments of each team's success or failure.

The focal point of descriptive data on the tactical event is the Exercise Diagram. On this diagram, major lines of movement for both Teams A and B are drawn, with local movement and positioning of major weapon systems. The points where tanks, TOWs,[1] armored personnel carriers (APCs), and infantry clusters became casualties are also indicated. An Exercise Narrative supplements the Exercise Diagram. Together they depict what took place on the simulated battlefield. A review of a sample REALTRAIN exercise is included in Appendix C of this study. (This

---

[1] TOW = Tube-launched, optically tracked, wire command linked guided missile system.

exercise was conducted at Training Site II during the third training week. Team A had two weeks of REALTRAIN experience, while Team B had only several days of REALTRAIN. A clear victory for Team A was the result of the exercise.)

The remaining forms within the first category of data collection provide supplementary details to help focus the Exercise Diagram and Exercise Narrative on special tactical behaviors. For example, the Tactical Data Supplement was designed to record initial detections, initial engagements, initial dismounting of infantry, use of TOWs, use of smoke, and win/lose status of the contestant teams. The Communication Record was designed to record all transmissions, including the sender and the receiver, within the internal radio nets of Teams A and B. The Artillery Control Sheet was used to record chronologically the number, type, and effects of preplanned and observed simulated artillery fire. The Major Events Record provided a form to list critical incidents felt by research team members to have an important bearing on the success or failure of a mission.

Casualty assessment encompassed two data collection forms. The Net Control Sheet provides the chronological casualty event record needed to conduct an After Action Review (and served as a major research data source). It was designed to isolate the target destroyed, the vehicle or individual inflicting the casualty, and the time. Casualty data were recorded during each exercise from the Net Control radio net linking each controller and senior controller to the Net Control Station (NCS).

Each weapon system controller recorded supplementary hit/miss data using the Controller Exercise Record for armor and anti-armor weapon systems. These data helped assess ammunition expenditure per casualty.

A third major tactical performance data source was the subjective judgment of team performance provided by Senior Controllers using the Team Performance Rating Form. Overall performance rating for each team (and its component tank platoon, infantry squads, TOW section and forward observer) were recorded. These data were collected to compare the subjective impressions of mission success with the more objective casualty assessments.

Indirect Measures

Indirect measures of REALTRAIN effectiveness represent a second major category of data.

The Participant Questionnaire gave participants the opportunity to give their opinions about REALTRAIN effectiveness. Participants were asked, for example, to estimate REALTRAIN'S impact on their unit's state of training.

The Leader/Controller Questionnaire asked similar questions of team leaders and student controllers, but in greater depth and detail. For example, comparisons to other training methods such as live fire, battle drill, and traditional field training exercises (FTXs) were requested. In addition, controllers were asked to indicate how effective their REALTRAIN instruction had been.

Logistic (Cost) Data

The logistic forms were used to record and process information on vehicle mileage and hours of use and consumption and usage of ammunition. These data provide a basis to estimate the costs of conducting REALTRAIN engagements. Of special interest was the Ammunition Usage Tabulation Sheet, designed to list daily expenditure of cartridge blanks, smoke grenades, and a variety of "flash-bang" simulation rounds.

Refinement Data

The fourth subcategory dealing with the REALTRAIN methodology included collecting data on the utility and effectiveness of the After Action Review. The After Action Review Record was used by research team personnel to describe various features of the review, e.g., mode of communication between AAR leader and participants, lessons learned, and relative amount of participation by the AAR leader.

RESULTS

FACTORS IN INTERPRETING RESULTS

Before discussing results, a number of important factors that had a potential influence on their interpretation should be identified.

1. The primary mission of the Mobile Training Team was to maximize the training of cadres in how to implement REALTRAIN in their home units. Collecting data on REALTRAIN effectiveness was therefore secondary. Because of this priority, MTT personnel sometimes intervened during an exercise to make sure that opposing elements made contact. Also, to increase the training exposure for cadre and players, exercises were often allowed to continue beyond the point where a prudent commander would withdraw.

2. There was a major difference in exposure times between A Teams and B Teams. This difference reflects the experimental variation introduced to test REALTRAIN training effectiveness. At each site, the A Team remained for a full three weeks. During these three weeks

three different B Teams reported, a new one each week. Thus, the basic training effectiveness analysis is a measurement of the tactical performance of one A Team over a three-week period compared to three different one-week B Teams.

Three weeks of continuous concentrated training exercises cannot be considered a likely or even desirable regimen. Future research will have to address the optimum spacing of REALTRAIN exercises. Related here is that there was no systematic remedial training between exercises to correct observed individual, crew or team performance deficiencies. This step is an integral part of REALTRAIN methodology.

3. The types of tactical missions were selected to maximize the learning of the battalion controller cadre. Thus, all exercises were either meeting engagement or attack/defense (delay). In both types of exercises, the ratio of opposing forces was 1:1, with a tank platoon, two infantry squads, and a TOW section on each side. This ratio is appropriate for meeting engagements, but presents unrealistic and unfavorable odds against an attacking unit in an attack/defense exercise. Many analyses here are, therefore, broken out by mission type. Team A was on the attack more often than B (15 vs. 11), and, consequently, more often at a disadvantage.

	Number of times in the Attack	
	Team A	Team B
Site I	5	4
Site II	1	3
Site III	3	1
Site IV	6	3
	15	11

4. Generalizations beyond the data presented should be made only after fully considering these additional points:

- Sample size. Although the total data volume is massive, the basic sample size is limited -- four A Teams and four sets of B Teams.

- Training sites. The four training sites differed considerably in size, terrain, degree of openness, and even in the quality of support provided. For example, After Action Reviews were held at one site outdoors in cold weather; at another, in a warm tent.

• Unit experience. Crews and teams were composed of individuals who had worked together previously for various amounts of time. Also, the initial level of training/performance of A and B Teams was not deliberately matched but assumed to be roughly equal.

• Mission type and unit size. As previously mentioned, the type of exercise mission was essentially limited to two (meeting engagement and attack/defense), and the unit size of study was a reinforced platoon. Extrapolation of the results to other missions and larger units is unwarranted.

• REALTRAIN experience. An intriguing but unmeasurable speculation concerns the differential effect of putting a new Team B each week against Team A opponents having a greater amount of REALTRAIN experience in Weeks 2 and 3. In Week 1, both A and B Teams should be roughly comparable, both lacking REALTRAIN experience; by Week 2, a new B Team faced an enemy with one week of REALTRAIN experience; and in Week 3, the A Team must have seemed quite formidable to the inexperienced B Team. It could be speculated that the higher challenge in Weeks 2 and 3 promoted a more rapid rate of learning for Team B than in Week 1 when both teams were inexperienced. An analogy may exist to other games and sports, e.g., tennis or chess, where a neophyte will learn the requisite skills more rapidly when opposing a skilled player than when opposing another neophyte.

5. A final issue in this discussion of interpreting results is the meaning of the terms "Win," "Loss," and "Tie." In most cases, two senior controllers and a member of the research team made the "Win-Loss-Tie" judgments of battle results subjectively, based on the available evidence. These evaluations were subjective because other factors besides personnel and vehicle casualties had to be weighed (mission accomplishment, elapsed time, terrain, weather, artillery rounds available, capability to continue). This does not imply that the decisions were capricious or without validity. On the contrary, the decisions carefully considered all aspects of play, and are probably representative of the best that can be expected of a basically subjective evaluation. As noted earlier, one of the research objectives was to obtain data to improve methods to evaluate unit performance. A later section will present such data.

OBJECTIVE RESULTS

The next four subsections contain the results of analyses conducted on the objective data collected during REALTRAIN implementation in USAREUR.

Summary of REALTRAIN Exercise Results

Number and Type of Exercise by Training Site. A total of 59 exercises were conducted during the REALTRAIN implementation in USAREUR.

Of these, 33 were meeting engagements and 26 were attack/defense (delay) exercises. The attack/defense (delay) missions were composed of 17 attack/defense missions and 9 attack/delay missions. A summary of the type of exercise by site is shown in Table 3. In this table and the two that follow, the fourth week at Site IV is shown in parentheses.

Table 3

NUMBER AND TYPE OF EXERCISE BY SITE

Site	Type of Exercise: Meeting Engagement	Attack	Total
I	6	9	15
II	10	4	14
III	9	4	13
IV	4 (4)	8 (1)	12 (5)
Total	29 (33)	25 (26)	54 (59)

At the conclusion of each exercise, a judgment was made concerning the outcome of the battle. The battle results were judged a "win," "loss," or "tie" by observers who were either members of the MTT or the research team. The judgments made were clearly subjective and are presented only as an approximation of the outcome. Although a precise definition of "win-loss-tie" has not been developed, the approximations are presented to demonstrate outcomes relating to mission type and weeks of training.

Table 4 presents the results of the meeting engagement missions over weeks of training. Remembering that the A Team remained at each site for three weeks while the B Teams changed each week, it may be seen from the table that the A Teams tended to win more engagements during the second, third, (and fourth) weeks.

Table 5 shows the results of the 26 attack/defense missions by training week. When equal forces meet in battle, the attacker is expected to be at a disadvantage. The table clearly illustrates this disadvantage, but also shows that with increased training Team A actually won one exercise in Week 2 and two exercises in Week 3 (Team B won none). Considering the force ratios involved, these wins were major accomplishments.

Table 4

MEETING ENGAGEMENT OUTCOMES BY TEAM AND WEEK OF TRAINING

Week of Training	A Team Win	B Team Win	Tie	Total
1	3	3	4	10
2	6	0	4	10
3 (4)	4 (3)	0 (1)	5	9 (4)
Total	13 (16)	3 (4)	13	29 (33)

Table 5

OUTCOMES FOR ATTACKER IN ATTACK/DEFENSE EXERCISES BY WEEK OF TRAINING

Week of Training	A Team Win	B Team Win	A Team Loss	B Team Loss	A Team Tie	B Team Tie	Total
1	0	0	4	3	0	0	7
2	1	0	2	3	1	1	8
3 (4)	2	0	3	3	1 (1)	1	10 (11)
Total	3	0	9	9	2 (3)	2	25 (26)

Summary of Casualty Data by Training Site and by Week of Training. The REALTRAIN Rules of Engagement in defining casualties delineate the range, accuracy, and lethality of weapons, and the vulnerability of targets to specific weapons. (See Appendix D.) When a weapon capable of damaging or destroying a target has proper range and aim, and firing is simulated, a casualty is assessed. Whether this casualty is counted as a "kill" or immobilized casualty is determined by the type of weapon used. The controller fills out the Net Control Sheet during each exercise to record when each casualty occurred and what weapon caused it.

Casualties, summarized by training site, and by week of training, are presented in Appendix E. The percent of casualties inflicted by the two teams, by weapon used for the various target types, is also summarized in Table 3 of Appendix E.

Training Effectiveness Results

REALTRAIN's effectiveness represents the REALTRAIN research projects's major concern. As explained, performance of combined arms teams having only one week of REALTRAIN training (Team B) was compared with that of teams having one, two, and three weeks of REALTRAIN training (Team A).

The analyses compare the performance of Teams A and B across the three weeks of REALTRAIN experience. The five analyses attempt to isolate variables discriminating between the two team types. Most of these attempts were successful. Where not successful, the direction of required further analyses is discussed.

Training Effectiveness Reflected by Casualties Incurred. The casualties incurred by both sides are the primary objective data in a REALTRAIN exercise. When tactical proficiency increases, casualties incurred should change in two ways. A combat unit should: (1) decrease the casualties incurred by proper cover, concealment, and movement techniques, and (2) increase casualties incurred by the opposing force by more effectively using its weapons.

Results are shown by type of exercise--meeting engagement or attack/defense (delay)--so that data trends can be clearly seen.

Meeting Engagements: Tables 6 through 9 show the percent casualties incurred by Team A and Team B for each week of training for tanks, infantry, APC, and TOW.

Table 6

COMPARISON OF TANK CASUALTIES FOR
TEAM A AND TEAM B
MEETING ENGAGEMENTS

	Week 1	Week 2	Week 3
A Team	48%	35%	36%
B Team	45%	46%	67%
	n=10	n=10	n=9

Tank Casualties: Table 6 shows that both teams incurred approximately the same proportion of casualties during the first training week (Team A: 48%, Team B: 45%), as would be expected when both teams have had the same limited amount of tactical training. For the second week of training, the percent of casualties incurred by Team A decreased from 48% to 35% while the percent of casualties incurred by Team B remained approximately the same. There is a large difference between the two teams, however, for the third week; Team A incurred 36% casualties, while Team B incurred 67% casualties. An analysis of variance on the differences (Team B - Team A) in tank casualties per exercise showed the average increase over weeks to be significant at the .10 level ($F_{2,17} = 3.37$). Table 10 further shows that from Week 1 to Week 3, Team A reduced its percent of casualties by 26% while Team B's percent of casualties increased by 49%. The difference in the percent of casualties incurred by the two teams in the final training week was 87%; i.e., Team B incurred 87% more tank casualties than Team A.

Table 7

COMPARISON OF INFANTRY CASUALTIES
(BY PERCENTAGE LOST)
FOR TEAM A AND TEAM B
MEETING ENGAGEMENTS

	Week 1	Week 2	Week 3
A Team	34%	40%	30%
B Team	49%	36%	55%
	n=10	n=10	n=9

Infantry Casualties: Table 7 shows that during the first week of training, Team B lost more infantrymen than Team A (49% to 34%). By the third week, the A Team reduced its casualties slightly (34% to 30%) while B Team casualties increased slightly (49% to 55%). Table 10 reveals that the percent of Team A casualties decreased 13% from Week 1 to Week 3 while the percent of Team B casualties increased by 11%. The same table also shows that the percent of casualties incurred by Team B was 84% greater than the percent of casualties incurred by Team A during the third and final training week.

Infantry casualties are not as clear-cut as tank casualties. While there was a demonstrable performance difference during the third week of

training between the two teams, performance during the first two weeks is not easily interpreted. Two factors may explain this fact: (1) Infantry squads must first learn to work as a cohesive unit, not as individuals. (2) After learning to work as a unit, infantry must work with armor personnel in a combined arms role, learning to move, shoot, and communicate with their armor counterparts for the team to be effective. Table 7 indicates that by the third week, the A Teams were beginning to get things "together"--reducing the casualties incurred on themselves and increasing the casualties inflicted on the B Teams.

Table 8

COMPARISON OF APC CASUALTIES (BY PERCENTAGE LOST) FOR TEAM A AND TEAM B MEETING ENGAGEMENTS

	Week 1	Week 2	Week 3
A Team	60%	45%	35%
B Team	55%	65%	40%
	n=10	n=10	n=9

APC Casualties: Table 8 indicates that over the three weeks of training, Team A's APC casualties tended to decrease weekly (60% in Week 1 to 35% in Week 3). Table 10 shows that this represents a 42% decrease in the percent of casualties. For Team B, casualties decreased 27% from Week 1 to 3.

Table 9

COMPARISON OF TOW CASUALTIES (BY PERCENTAGE LOST) FOR TEAM A AND TEAM B MEETING ENGAGEMENTS

	Week 1	Week 2	Week 3
A Team	90%	19%	33%
B Team	90%	50%	44%
	n=10	n=10	n=9

TOW Casualties: Table 9 shows that both teams lost most of their TOWs during the first training week. There was a very noticeable decrease in TOW casualties during the second and third weeks of training, with Team A showing the greatest decrease. As shown in Table 10, from Week 1 to 3, Team A showed a 64% decrease in the percent of TOW casualties while Team B showed a 51% decrease. The same table shows that the percent of casualties incurred by Team B was 33% greater than the percent of casualties incurred by Team A during the final week.

Attack/Defense/Delay Exercises: As stated, the 25 attack/defense exercises during Weeks 1 to 3 were conducted with an equal, 1:1 force ratio, to provide student controllers with maximum REALTRAIN experience. Results must be interpreted in view of this unrealistic force ratio.

The results of Team A and B weekly performance are presented according to the 14 exercises in which Team A was in the attack ("Team A Attacks") and the 11 exercises in which Team B was in the attack ("Team B Attacks"). Tables 11 through 14 show the percent casualties incurred by Team A and Team B for tank, infantry personnel, TOW, and APC.

Meaningful trends in the data are difficult to identify. A discernible trend, however, may be noted in Table 12, Infantry Casualties. The left portion shows that Team A was able to inflict an increasing percentage of casualties on the B Team for the three weeks of training and, for the third week, A Teams sustained fewer casualties than B Teams. During this week, Team A actually won two out of six exercises in which they were on the attack.

In order to take a somewhat different look at the available data, the various categories of casualties were combined into a Weighted Casualty Index (WCI), derived from but not identical to an outcome

Table 10

COMPARISON OF TEAM A AND TEAM B PERFORMANCE
FOR WEEKS 1 AND 3 (MEETING ENGAGEMENTS)

	Percent Casualties Week 1		Percent Casualties Week 3		Percent Decrease (Increase) in Percent of Casualties: Wk 1 to 3[a]		Percent Differ. In Percent Casualties Week 3[b]
	Team A	Team B	Team A	Team B	Team A	Team B	(B-A/A)
Tank Casualties	48%	45%	36%	67%	26%	(49)%	87%
Infantry Casualties	34%	49%	30%	55%	13%	(11)%	84%
APC Casualties	60%	55%	35%	40%	42%	27%	14%
TOW Casualties	90%	90%	33%	44%	64%	51%	33%

[a] 100 [(Week 1 % - Week 3 %)/Week 1 %].

[b] 100 [(Team B % - Team A %)/Team A %].

Table 11

COMPARISON OF TANK CASUALTIES (BY PERCENTAGE LOST) FOR TEAM A AND TEAM B, ATTACK/DEFENSE

	Team A (Attacks)	Team B	Team B (Attacks)	Team A
Week 1	65%	35% (n=4)	47%	15% (n=3)
Week 2	35%	30% (n=4)	40%	10% (n=4)
Week 3	48%	27% (n=6)	60%	35% (n=4)

Table 12

COMPARISON OF INFANTRY CASUALTIES (BY PERCENTAGE LOST) FOR TEAM A AND TEAM B, ATTACK/DEFENSE

	Team A (Attacks)	Team B	Team B (Attacks)	Team A
Week 1	39%	17% (n=4)	42%	21% (n=3)
Week 2	82%	27% (n=4)	56%	55% (n=4)
Week 3	48%	54% (n=6)	42%	40% (n=4)

Table 13

COMPARISON OF APC CASUALTIES (BY PERCENTAGE LOST) FOR TEAM A AND TEAM B, ATTACK/DEFENSE

	Team A (Attacks)	Team B	Team B (Attacks)	Team A
Week 1	63%	50% (n=4)	17%	17% (n=3)
Week 2	50%	38% (n=4)	50%	25% (n=4)
Week 3	25%	33% (n=6)	50%	0% (n=4)

Table 14

COMPARISON OF TOW CASUALTIES (BY PERCENTAGE LOST) FOR TEAM A AND TEAM B, ATTACK/DEFENSE

	Team A (Attacks)	Team B	Team B (Attacks)	Team A
Week 1	25%	25% (n=4)	33%	17% (n=3)
Week 2	50%	63% (n=4)	63%	43% (n=4)
Week 3	33%	42% (n=6)	13%	38% (n=4)

criterion index of the Unit Performance Assessment Model (UPAM).[2] Casualty data were not collected in a form to permit the UPAM criterion index to be applied directly.

The Weighted Casualty Index (WCI) used was:

WCI = 35 (# tanks immobilized or killed)
+ 25 (# TOWs killed) + 15 (# APCs killed)
+ 1 (infantry casualties)

The use of a weighted index allows diverse data categories to be integrated into a single measure. Weightings in the WCI are based on expert military judgment and are in general agreement with weightings in other firepower indices. As documented elsewhere in this report, exercise outcomes derived from performance ratings by MTT, and those determined by differences in the WCI, strongly agreed. Stockfisch, however, questions the validity of all firepower indices.[3] An area for important future research may be to test empirically various data aggregation indices, by using engagement simulation techniques such as REALTRAIN.

Figure 1 shows the average WCI for Team A Attacks and Team B Attacks by training week. The top of the figure shows that by Week 3 Team A in the attack was able to reduce combined casualties by 32% (from a WCI of 198 in Week 1 to 134 in Week 3); the Team B index was approximately the same for Weeks 1 and 3 (Week 1: 119; Week 3: 117). The bottom portion shows that when Team B was in the attack, the combined index for Team A went from 98 in Week 1 to 81 in Week 3, a decrease of 17, while the Team B casualty index increased slightly (from 160 to 171).

The results using the WCI become even more dramatic and trends more discernible when the differences in WCI scores between the two teams are examined.

---

[2]The UPAM model was developed for the Army Research Institute under the Unit Training and Evaluation Systems research program. Criterion variables and their weights were derived by multiple linear regression analysis. The dependent variable used in the regression analysis was a scale of outcome of hypothetical combined arms exercises. Military experts served as judges in the scaling of exercise outcomes. WCI composite and UPAM composite have three variables in common: tanks immobilized or killed, APCs killed, and major weapons (TOWs) killed. The fourth UPAM variable is "able to continue the mission." The fourth WCI variable is infantry casualties.

[3]Stockfisch, J. A. Models, Data, and War: A Critique of the Study of Conventional Forces, The Rand Corporation, R-1526-P.R., March 1975.

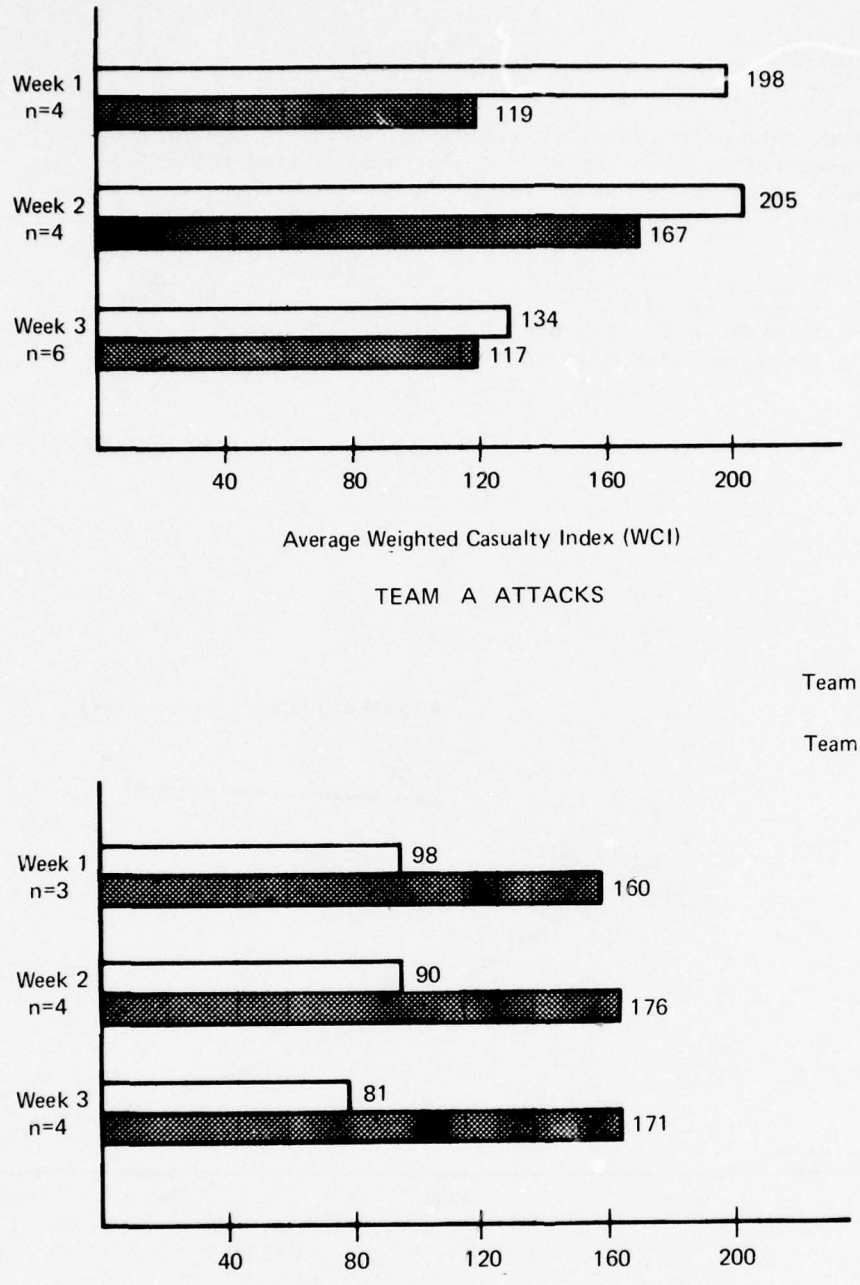


Figure 1: Weighted Casualty Index (WCI) for Team A and Team B Attacks

Figure 2 shows that with increased training, Team A on the attack decreases its losses relative to those of B in almost a linear fashion for the three weeks of training. When Team B is on the attack, on the other hand, its losses increase relative to the losses of Team A.

Training Effectiveness Across All Exercises as Measured by the Weighted Casualty Index. Casualties incurred by all A Teams and opposing B Teams for each week in the training cycle, measured by the Weighted Casualty Index, are compared in Table 15 and Figure 3.

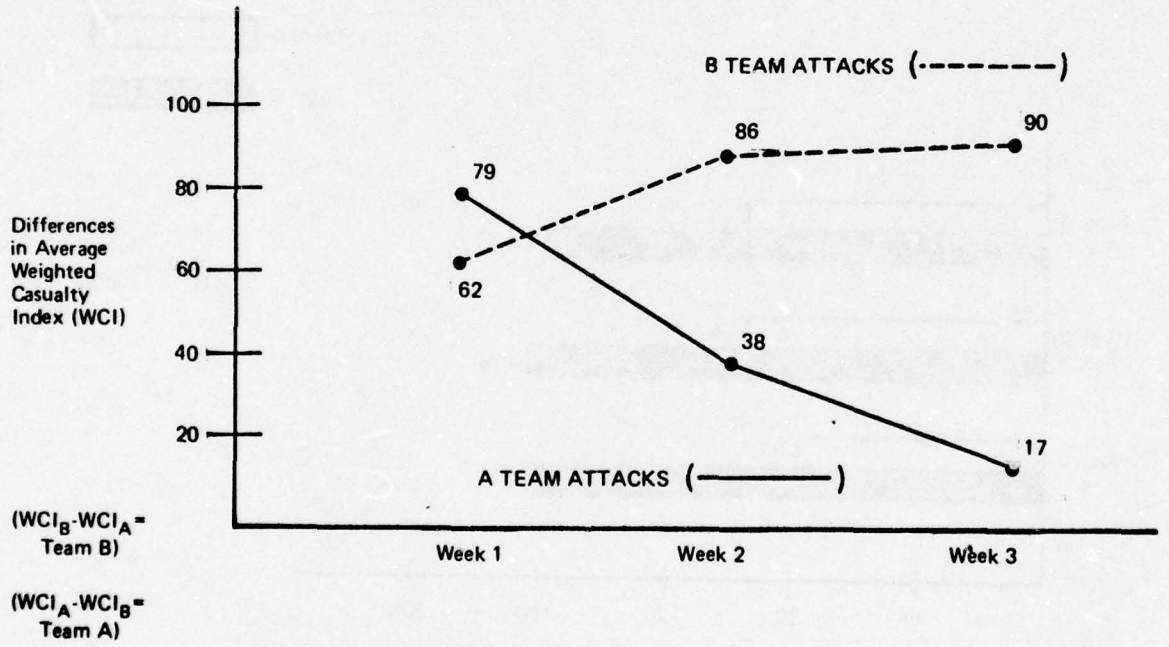


Figure 2: Differences in Weighted Casualty Index (WCI) as a Function of Week of Training

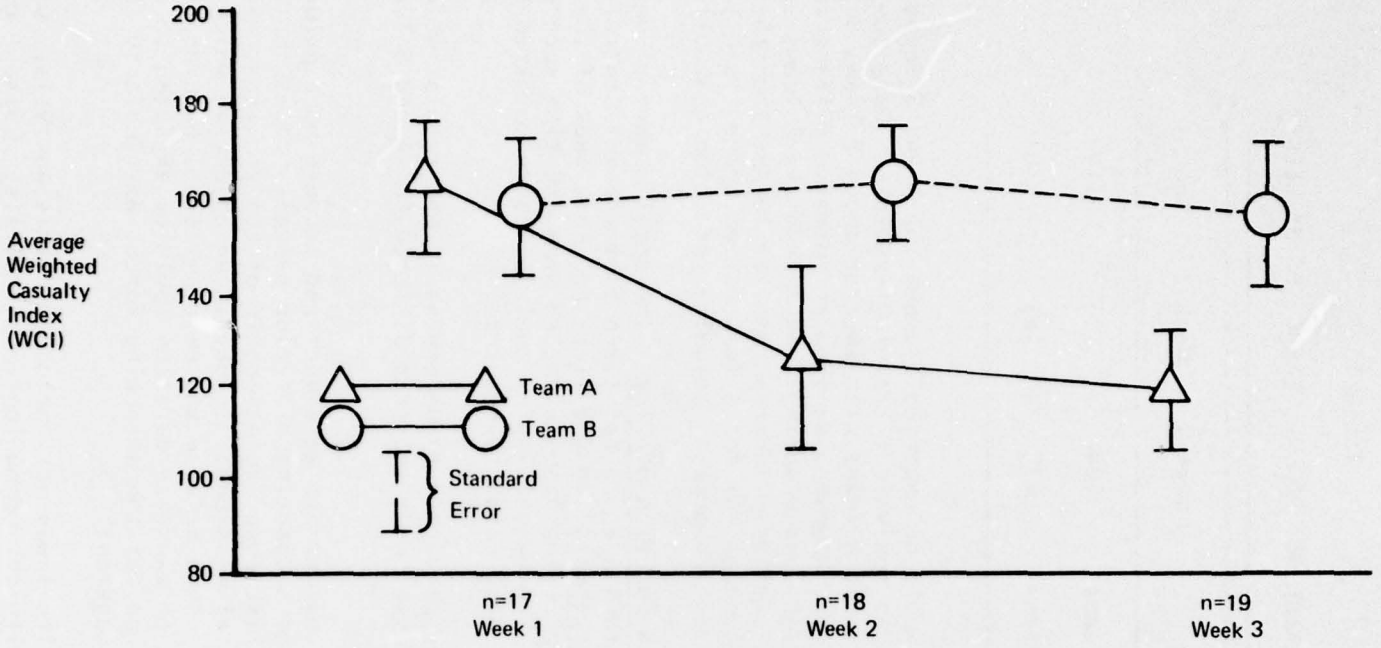


Figure 3: Average Weighted Casualty Index (WCI) for All Exercises by Weeks

Table 15

AVERAGE WCI FOR ALL EXERCISES BY WEEKS

	Week 1	Week 2	Week 3
A Teams	164	126	119
B Teams	159	163	156

No difference would be expected between the A and B Teams during Week 1, since both had equivalent training exposure. Data comparing increasingly experienced A Teams with inexperienced B Teams during the second and third weeks, however, do show performance differences. A Teams incurred smaller losses during Week 2 than the B Teams ($p < .10$). For Week 3, A Teams similarly incurred smaller losses than the B ($p < .05$). A comparison of WCI for A Team during Weeks 1 and 3 shows a significant improvement in overall casualty reduction ($p < .01$).

Casualties as a Function of Time. The total number of vehicles and personnel for Teams A and B was taken from the Net Control Sheet for all meeting engagements[4] in the first and last week of the training at Sites II, III, and IV.[5] Also extracted were the time each exercise started and ended; the casualties or vehicle losses incurred by either team; and the time each casualty occurred.

An analysis was performed to determine if the rate at which casualties or vehicle losses were incurred differed for A and B Teams early

[4]Only meeting engagements were analyzed because no a priori reasons could be isolated for suspecting differing casualty rates in them over time. The initial fire power relationship of the two teams was equal, and both had identical missions: to obtain an objective which was behind enemy lines. In a defense and delay mission, however, casualty rates as a function of exercise duration would be expected to be lower for the defenders than for the attacking force, particularly in the beginning of the engagement.

[5]Training at Site I was not included in this analysis. Original data were reduced with the communications analysis; Site I communication data were not recorded.

and/or late in the training series. The rationale behind this analysis was that REALTRAIN-training exercises often were allowed to proceed well beyond what would reasonably have been judged as the end of a battle. It seemed appropriate to determine the rate at which A and B Teams incurred personnel and/or vehicle losses as a function of the exercise's duration. Since the time that each casualty or vehicle loss incurred was recorded, it was possible to calculate what portion of the exercise had passed when Team A or B had lost 10, 20, or 30 percent of its personnel; or when one, two, three or four tanks were lost; or when one or two TOWs were destroyed. This comparison was thought to be an appropriate vehicle to look at the cumulative effect of REALTRAIN-training on the ability of experienced A Teams to avoid casualties more effectively than less-experienced B Teams.

Entries in Table 16 show at what point in an exercise, personnel casualties were incurred for Teams A and B. These data are shown for early and late exercises in the three training series. Parametric and nonparametric statistical analyses indicated there were no significant differences in the rates personnel casualties were incurred between A and B Teams early or late in the training series.

Table 17 shows at what point one, two, three, or four tanks (TKs), or one or two TOWs (TWs) were lost in the exercise, as well as the final percent personnel casualties (F) for each team. Again, data are presented for exercises early and late in the series. Statistical analysis demonstrated no significant differences between tank and TOW losses for A and B teams or between early and late exercises in the training series.[6]

Indirect Fire Effectiveness. Data extracted from the Artillery Control Sheets were the number of simulated rounds fired by each team. In the analysis of the Artillery Control Sheets, all raw data were converted into number of rounds that actually would have been fired.

---

[6]While the results of the present analysis do not show significant differences in casualties incurred as a function of exercise duration for A and B Teams in the first and last weeks of training, the methodology and its rationale may help in developing a unit performance model for REALTRAIN-training exercises. It is reasonable to assume that after a certain percent of casualties are incurred, the organizational integrity of a unit begins to deteriorate. Having teams continue to engage after 70% casualties and 80% vehicle losses may be useful or cost-beneficial for training purposes, but continued engagement at this point would be unrealistic in real combat. It may be feasible to develop a multidimensional index of proficiency for win/loss information from data collected during training exercises by looking at only that portion of an exercise where fire power levels and relationships are realistically maintained from the viewpoint of the real battlefield and by assessing organizationally intact units.

Table 16

PERCENT OF EXERCISE DURATION BEFORE "X"%
CASUALTIES INCURRED

	Percent Casualties											
	10	20	30	40	50	60	10	20	30	40	50	60
TM A:							TM B:					
Late in Training Series:							Late in Training Series:					
$\bar{X}$	50	65	69	71	72	84	45	53	63	74	80	80
SD	20	17	14	13	07	12	18	17	18	21	22	28
SE	06	05	05	05	04	07	05	05	05	08	09	14
N*	11	10	8	8	4	3	11	11	11	8	6	4
Early in Training Series:							Early in Training Series:					
$\bar{X}$	49	64	73	92	92	/	46	58	65	70	64	74
SD	23	19	13	35	34	/	18	20	20	21	18	23
SE	08	07	05	15	20	/	06	07	07	08	10	14
N*	8	8	7	6	3	/	8	8	8	7	3	3

*Number of exercises contributing data to mean; not all exercises ran to the same percent casualties. In early training, there were 8 exercises; in late training, there were 11.

Table 17

PROPORTION OF EXERCISE DURATION BEFORE TANKS (TK) AND TOWS (TW) ARE DESTROYED

	TM A							TM B						
	TK[*1]	TK[2]	TK[3]	TK[4]	TW[1]	TW[2]	Final %[**]	TK[1]	TK[2]	TK[3]	TK[4]	TW[1]	TW[2]	Final %
Late in Series:														
$\bar{X}$	.60	.65	.70	/	.66	.75	.46	.46	.63	.74	.89	.47	.68	.55
SD	.25	.16	.07	/	.26	.20	.20	.21	.17	.14	/	.30	.33	.20
SE	.08	.07	.04	/	.09	.10	.06	.07	.07	.08	/	.10	.15	.06
N[†]	9	7	4	1	9	4	11	10	6	3	2	8	5	11
Early in Series:														
$\bar{X}$	.52	.67	.79	.87	.67	.76	.43	.51	.59	.64	.82	.63	/	.55
SD	.15	.19	.11	.08	.22	.12	.10	.25	.23	.25	.16	.30	/	.19
SE	.06	.08	.05	.06	.10	.09	.04	.09	.06	.11	.10	.13	/	.07
N	6	6	5	2	5	2	8	8	7	5	3	5	/	8

[*] TK^1 = One tank destroyed; TW^2, for example, would be two TOWs destroyed.

[**] Final % = The final percent personnel casualties incurred by that team by the end of the exercise.

[†] Number of exercises contributing data to mean.

Tables 18 through 21 summarize the data for all sites by meeting engagements (Table 18), Team A on the attack (Table 19), Team B on the attack (Table 20), and all missions (Table 21). The tables show performance of the two teams as a function of training week, and summarize performance over all training weeks. The data are collapsed over training sites because there are too few exercises at a single site for trends to appear.

In reducing the raw data, casualty counts were based on casualties inflicted rather than casualties received. All casualties were equally weighted. For example, for purposes of the indirect fire analysis, an immobilized tank was equivalent to a destroyed APC or an individual soldier killed. Since a casualty could not be linked to a specific fire mission, it was not possible to analyze indirect fire usage as a function of casualty type inflicted. Equal weighting of casualties seemed the most reasonable alternative.

Six summary statistics are reported: "TOTAL CASUALTIES INFLICTED" and "TOTAL ROUNDS" are found by summing the appropriate figures from all exercises included in the scope of the table. "CASUALTIES/ROUND" is calculated by dividing the TOTAL CASUALTIES INFLICTED by TOTAL ROUNDS. It is a general index of the efficiency of indirect fire use; it is not strictly an average. Rather, it treats all meeting engagements which occurred during a particular week as one meeting engagement, for example. "AVERAGE CASUALTIES PER EXERCISE" and "AVERAGE ROUNDS PER EXERCISE" are found by dividing the TOTAL CASUALTIES INFLICTED and TOTAL ROUNDS, respectively, by the number of exercises. The value for "CASUALTIES/ROUND/EXERCISE" is found by summing the CASUALTIES/ROUND values found in each exercise included in the table, and then dividing by the number of exercises. Since this is an average of ratios, its value cannot be derived directly from other values included in the tables.

The data for meeting engagements is contained in Table 18. Over the three-week training period, both Teams A and B increased the number of casualties they were able to inflict with indirect fire. In Weeks 2 and 3, however, Team A accounted for considerably more casualties than Team B. A general increase in casualty-producing use of artillery is seen for Team A. Team B's performance is more erratic and less dramatic. The increased casualties are accompanied by mixed performance by both teams in the number of rounds fired. This is reflected in the lack of a trend appearing in either of the efficiency indices. Overall, Team A inflicted more casualties but fired more rounds than Team B. This resulted in Team B appearing slightly more efficient than Team A.

The data for exercises in which Team A was on the attack (Table 19) indicate that Team B was able to inflict more casualties than Team A for the first two weeks of training. During the third week, however, a dramatic reversal is observed. The third week is particularly impressive since the A Team was able to inflict far more casualties than the B Team with far fewer rounds. In general, Team A used less indirect fire than

Table 18

INDIRECT FIRE ANALYSIS ALL SITES:
MEETING ENGAGEMENT BY WEEK

		Total Casualties Inflicted	Total Rounds	Casualties/ Round	Average Casualties/Ex.	Average Rounds /Ex.	Casualties/Rd. /Ex.
Week 1 (10)	A	35	645	.05	3.5	64.5	.06
	B	39	426	.09	3.9	42.6	.09
Week 2 (10)	A	61	359	.17	6.1	35.9	.24
	B	37	530	.07	3.7	53.0	.23
Week 3 (9)	A	62	827	.08	6.9	91.9	.07
	B	49	259	.19	5.4	28.8	.15
All Weeks (29)	A	158	1831	.09	5.4	63.1	.13
	B	125	1215	.10	4.3	41.9	.16

Table 19

INDIRECT FIRE ANALYSIS ALL SITES:
TEAM A ATTACK BY WEEK

		Total Casualties Inflicted	Total Rounds	Casualties/ Round	Average Casualties/Ex.	Average Rounds /Ex.	Casualties/Rd. /Ex.
Week 1 (4)	A	18	349	.05	4.5	87.3	.06
	B	21	222	.10	5.3	55.5	.07
Week 2 (4)	A	22	235	.09	5.5	58.8	.17
	B	43	1083	.04	10.8	270.8	.14
Week 3 (6)	A	56	420	.13	9.3	70.0	.14
	B	22	895	.03	3.7	149.2	.05
All Weeks (14)	A	96	1004	.10	6.9	71.7	.12
	B	86	2200	.04	6.1	157.1	.08

Table 20

INDIRECT FIRE ANALYSIS ALL SITES:
TEAM B ATTACK BY WEEK

		Total Casualties Inflicted	Total Rounds	Casualties/ Round	Average Casualties/Ex.	Average Rounds /Ex.	Casualties/Rd. /Ex.
Week 1 (3)	A	46	216	.21	15.3	72.0	.18
	B	17	242	.07	5.7	80.7	.03
Week 2 (4)	A	35	247	.14	8.8	61.8	.19
	B	45	942	.05	11.3	235.5	.07
Week 3 (4)	A	21	701	.03	5.25	175.3	.09
	B	22	892	.03	5.50	223.0	.02
All Weeks (11)	A	102	1164	.09	9.3	105.8	.15
	B	84	2076	.04	7.6	188.7	.04

Table 21

INDIRECT FIRE ANALYSIS ALL SITES:
ALL EXERCISES BY WEEK

		Total Casualties Inflicted	Total Rounds	Casualties/ Round	Average Casualties/Ex.	Average Rounds /Ex.	Casualties/Rd. /Ex.
Week 1 (17)	A	99	1210	.08	5.8	71.2	.08
	B	77	890	.09	4.5	52.4	.08
Week 2 (18)	A	118	841	.14	6.6	46.7	.21
	B	125	2555	.05	6.9	141.9	.17
Week 3 (19)	A	139	1948	.07	7.3	102.5	.10
	B	93	2046	.05	4.9	107.7	.09
All Weeks (54)	A	356	3999	.09	6.6	74.1	.13
	B	295	5491	.05	5.5	101.7	.11

Team B, and this is reflected in the higher efficiency values for Team A. Overall, Team A was able to inflict more casualties than Team B while firing fewer rounds, resulting in a higher overall efficiency for Team A.

The data for Team B on the attack (Table 20) indicate that Team A had a particularly successful first week of training. It was able to inflict many more casualties than the B Team using about the same number of rounds, resulting in a high efficiency for Team A. In Week 2, Team B was able to inflict more casualties than Team A, but needed an extraordinary number of rounds to do so. In Week 3, neither team was able to inflict as many casualties as they had earlier in training and both fired a large number of rounds. Overall, Team A had a higher efficiency value as it inflicted more casualties with fewer rounds than Team B.

Overall data (Table 21) indicate that Team A gradually increased the number of casualties inflicted by indirect fire over the three-week period. Team B did not show this trend and inflicted fewer casualties than Team A through all exercises and training weeks. Team A was relatively stable in the number of rounds expended per exercise compared to a gradual increase for Team B. Overall, Team B fired considerably more rounds than Team A. Both teams show a slight increase in efficiency, but Team A's increase is greater and Team A is consistently more efficient than Team B.[7]

Communications Analysis. Research personnel monitored the tactical internal radio nets of Teams A and B at Sites II, III, and IV. All radio communications for each team were manually transcribed. The sender and receiver were identified, and the time of each communication was recorded.

Communication data have been analyzed two ways. The first analysis covered the number of communications per unit time for Teams A and B for meeting engagements only. The second analysis looked at Team A and B communication performance before and after casualties were incurred, again for meeting engagements only. Attack/defense (delay) exercises were not analyzed, since the different missions of the attacker and defender would presumably influence team's communication rates. For example, a team moving to engage would presumably use their radio net differently than a team "dug-in" to defend a particular position. Only exercises in the first and last week of a training series were considered.

---

[7] It could not be determined whether an artillery mission called was for observed or unobserved targets, nor could casualties be tied to specific fire missions. Future data collection should provide such added information.

For the first analysis a Communication Index (C.I.) was calculated to reflect the extent that each team's radios were used during the exercise. This Index is described in Appendix F. Difference scores for Communication Indices and Casualty Rates are shown in Table 22, as well as subjective estimates of outcome. This tabular comparison was made to:

(1) Determine if the communication rate (Communication Indices) varied with amount of training (A Teams vs. B Teams for first and last weeks in series).

(2) Determine if the relative difference in communication rates for A and B (percent difference score) varied with the amount of training.

(3) Assess if either (1) or (2) was related to the rate at which casualties were inflicted (casualty rate) and/or subjective estimates of the MTT regarding win, lose, or tie.

Table 22 compares teams' Communication Indices to Casualty Rates and subjective estimates of outcome. Early in the training series, A Teams tended to communicate on the average 10% more. There is no significant association, however, between the percent difference scores for Communication Indices and for Casualty Rates, for exercises either early or late in the training series.

Communication rate does not appear to be related to casualty rate or to estimates of exercise outcome either early or late in training series. Although the average C.I. for A Teams went up 10% from early to late exercises, B Team's C.I.'s also increased an average of 14%.

Figure 4 is a graphic analysis of variables as a function of time for one exercise, covering the actual number of communications per ten-minute interval, the Communication Indices, the cumulative number of casualties inflicted, and vehicular events (i.e., tanks, TOWs, or APCs destroyed or immobilized). The analytic power of a graphical representation is limited, but this technique facilitates simultaneous comparison of types of information as a function of time.

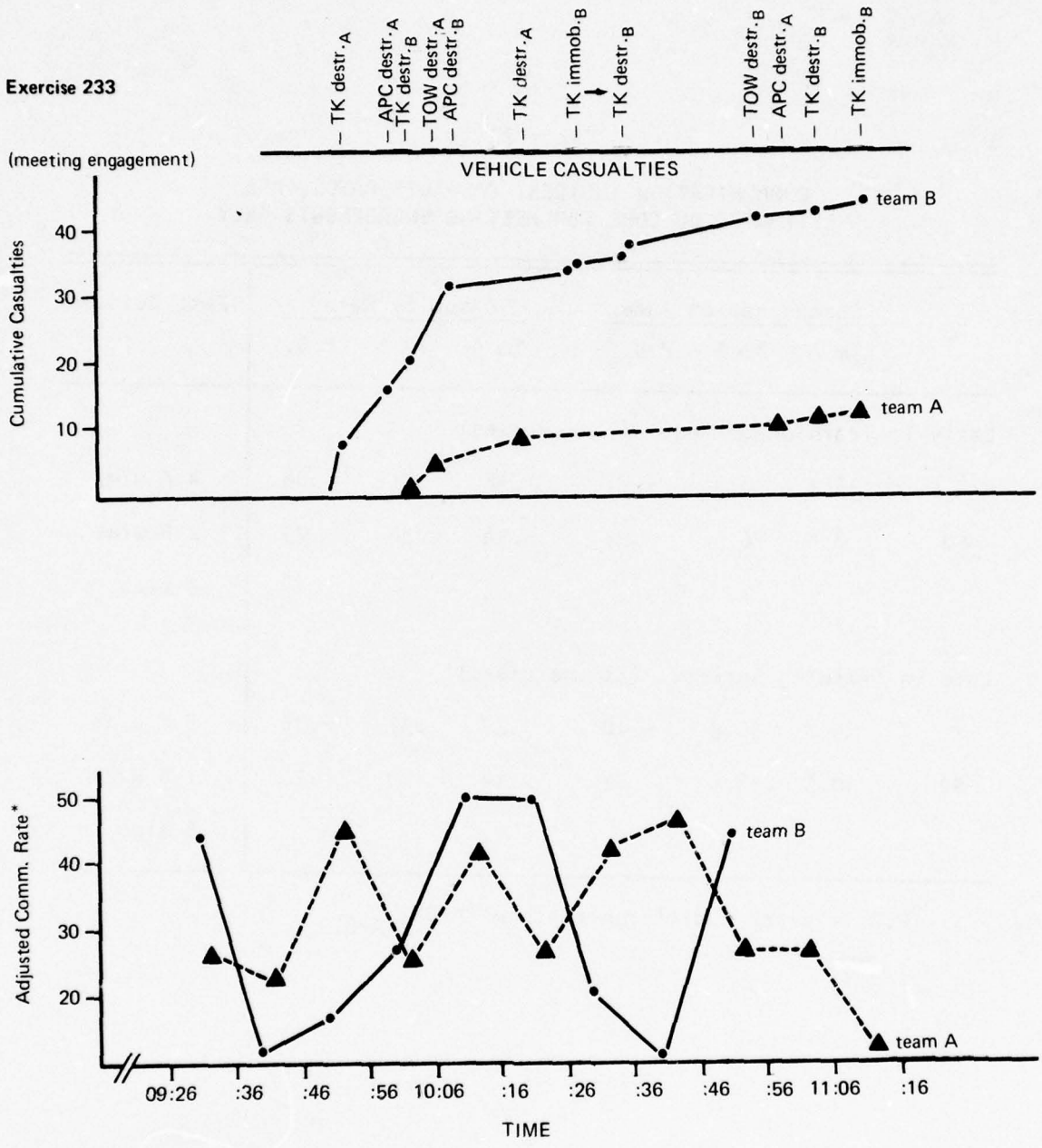
The second major analysis looked at the Communication Indices for Teams A and B before and after casualties were incurred. The logic behind this analysis was that certain changes in using the communications net might have occurred after the two sides engaged. Percent difference scores were calculated for Communication Indices of Teams A and B to determine whether there had been an increase or decrease in communication rate after casualties started. These percent difference scores were compared to casualty rates, calculated by dividing the number of casualties by the time interval in which casualties were inflicted. This casualty rate gives a measure of action density of over time for both teams.

Table 22

COMMUNICATION INDICES, CASUALTY RATES, AND ESTIMATED OUTCOME FOR MEETING ENGAGEMENTS ONLY

	Communication Index			Casualty Rate			Est. Outcome
	Tm A	Tm B	P.D.*	Tm A	Tm B	P.D.	
Early in Training Series: (9 exercises)							
$\bar{X}$	25.1	20.9	-.21	.48	.51	-.06	4 A wins
SD	8.5	6.3	.03	.34	.34	.25	2 B wins
							3 ties
Late in Training Series: (12 exercises)							
$\bar{X}$	35.8	35.3	+.10	.27	.32	-.16	5 A wins
SD	10.5	18.4	.06	.14	.20	.27	1 B wins
							6 ties

*P.D. = percent difference score $(A-B)/(A+B)$.



*Adjusted Communication Rate = Rate at which radios were used by each team per ten minute interval adjusted for personnel casualties.

Figure 4: Vehicle Casualties, Cumulative Personnel Casualties, and, Communication Rate as a Function of Exercise Duration.

Changes in communication rate before and after action and casualties start should presumably be related to the action density for an experienced team. When the casualty rate is heavy and things are happening quickly, for an experienced unit there should be decreased reliance on radio communication. For this reason, the percent difference scores for Teams A and B, before and after action began, were correlated with the casualty rate showing density of action for each team. Correlations were calculated for Teams A and B early and late in the training series to determine if for Team A, after two weeks of training together, there was a relationship between the percent difference for pre- and post-action C.I.s and casualty density.

Table 23 presents Communication Indices for Teams A and B before and after casualties were incurred for the two teams; a percent difference score reflecting the change in communication rate after casualties were incurred; and the casualty rate for Teams A and B, and the percent difference score for these casualty rates.

For both A and B Teams, the communication rate change after casualties began was not significantly correlated with casualty rate for exercises occurring early in the training series. For exercises later in the training series, A Teams had a .43 correlation ($t=1.43$, $df=10$, $p<.10$) between the change in communication rate and casualty rate. Team B's correlation was .24. After training at least two weeks, a significant association developed for Team A between communication rates before and after casualties started, and the rate they suffered casualties. As difference scores decreased (i.e., tending towards less communication after casualties began), the casualty rate became lower. Since A Team exhibited this association only for exercises occurring later in the training series, it is possible that REALTRAIN-training may have developed cohesive unit activity.

The results of the two completed analyses on the communications data from REALTRAIN/USAREUR have not yielded conclusive evidence that three weeks of REALTRAIN training affects the way a unit uses its radios.

The first analysis indicated, however, that A Teams generally tended to use their radio nets less than B Teams early in the series of training exercises, and somewhat more than B Teams after two weeks of training. There appeared to be no measurable association between the rate A or B Teams used their radios and the rate they incurred casualties, or the estimated outcome of the exercise provided after each exercise by the MTT.

The second analysis indicated that for exercises late in the series A Team demonstrated a significant positive correlation between the percent difference score for pre- and post-casualty Communication Indices and Casualty Rate.

Table 23

COMMUNICATION RATES BEFORE AND AFTER CASUALTIES, AND CASUALTY RATES FOR MEETING ENGAGEMENTS ONLY

	Communication Indices						Casualty Rates		
	Tm A			Tm B					
	Before*	After	P.D.	Before	After	P.D.	Tm A	Tm B	P.D.
Early in Training Series: (9 exercises)									
$\bar{X}$	25.10	27.70	+.07	16.80	27.60	.22	.73	.80	.02
SD	10.20	10.10	.26	5.80	13.90	.29	.37	.44	.23
Late in Training Series: (11 exercises)									
$\bar{X}$	29.90	32.60	.03	33.70	35.80	.07	.70	.72	.04
SD	13.30	17.30	.44	22.80	17.40	.16	.37	.62	.42

*Before = Before casualties started for that team.
**P.D. = Percent difference score $(A-B)/(A+B)$.

Performance Differences in Terms of Initial Detection and Initial Engagement. In order to determine the possible relationship between which side first detected or engaged the other and amount of training received, the team that initially detected the other was studied to see how quickly they detected the other team and at what range.

Data are summarized in Tables 24 through 27. Table 24 contains the number of times that each team initially detected and engaged. Data are broken down by training site and training week, then summed over all weeks and sites. Only meeting engagements were used to compare the two teams because attack/defend missions (Table 25) give a clear advantage to the defending team for both initial detection and initial engagement, potentially masking any improvement due to training. Table 26 summarizes data for time and range of engagement by training week. Table 27 shows, by training site, the times a particular weapon system inflicted the initial casualty for both meeting engagements and attack/defend missions.

Table 24

TEAM MAKING INITIAL DETECTION AND INITIAL ENGAGEMENT
BY TRAINING WEEK (MEETING ENGAGEMENTS)

Training Site	Week 1 Team A	Week 1 Team B	Week 2 Team A	Week 2 Team B	Week 3 Team A	Week 3 Team B	Weeks 1,2,3 Team A	Weeks 1,2,3 Team B
Site I								
Initial Detector	1	2	2	0	NA*	NA	3	2
Initial Engager	1	2	2	0	0	1	3	3
Site II								
Initial Detector	0	2	2	1	4	1	6	4
Initial Engager	1	1	2	1	5	0	8	2
Site III								
Initial Detector	3	1	2	1	0	2	5	4
Initial Engager	3	1	3	0	0	2	6	3
Site IV								
Initial Detector	1	0	1	1	1	0	3	1
Initial Engager	1	0	2	0	1	0	4	1
All Sites								
Initial Detector	5	5	7	3	5	3	17	11
Initial Engager	6	4	9	1	6	3	21	8

*Not available

Data in Table 24 indicate that for meeting engagements the frequency with which Team A first detected and engaged Team B tended to increase with training. During the first week, the two teams are relatively equal. For Weeks 2 and 3, Team A first detected and engaged twice as often as Team B. The total figures, summed over four sites and the three training weeks, also give Team A this 2:1 advantage. Chi square analysis of the data, on the number of times each team made the initial detection and engagement for Week 1 to Week 3, indicated there was no significant difference in frequency of initial detection for Teams A and B. Analysis

showed, however, that Team A was significantly more likely to initiate the engagement ($\chi^2 = 11.40$, 2 df, $p<.005$).

Table 25

INITIAL DETECTOR OR ENGAGER AS A FUNCTION OF MISSION IN ATTACK/DEFEND EXERCISES

Training Site	Attack	Defend
Site I		
Initial Detector	2	6
Initial Engager	3	6
Site II		
Initial Detector	0	4
Initial Engager	2	2
Site III		
Initial Detector	0	4
Initial Engager	0	4
Site IV (4 weeks)		
Initial Detector	3	2
Initial Engager	6	3
All Sites		
Initial Detector	5	16
Initial Engager	11	15

Table 25 contains the data for attack/defend missions. For Sites I, II, and III, the defending side has a clear advantage in initially detecting and engaging the attacking side. Only at Site IV did the attacking team first detect and engage the defending team more frequently. The three times that the attacking team was the initial detector, the attacking team was Team A. Similarly, Team A was on the attack four of the six times that the attacking team inflicted the first casualties.

Table 26

INITIAL DETECTION AND INITIAL ENGAGEMENT (IN MINUTES AFTER START AND RANGE) BY TEAM AS A FUNCTION OF TRAINING WEEK: MEETING ENGAGEMENTS

	Team A				Team B			
	Initial Detection		Initial Engagement		Initial Detection		Initial Engagement	
	Minutes After Start	Range (Meters)	Minutes After Start	Range (Meters)	Minutes After Start	Range (Meters)	Minutes After Start	Range (Meters)
Week 1	16.8	860.0	22.7	766.7	17.2	294.0	17.3	317.5
	(5)	(5)	(6)	(6)	(5)	(5)	(4)	(4)
Week 2	16.6	692.9	21.8	770.0	22.0	766.7	8.0	1500.0
	(7)	(7)	(9)	(6)	(3)	(3)	(1)	(1)
Week 3	7.5	1110.0	14.2	870.0	7.7	1000.0	6.0	750.0
	(4)	(5)	(6)	(5)	(3)	(3)	(3)	(2)
Weeks 1, 2, & 3	14.4	844.1	19.9	798.2	15.9	615.5	11.9	610.0
	(16)	(17)	(21)	(17)	(11)	(11)	(8)	(7)

NOTE: The numbers in parentheses indicate the number of entries included in computing each average.

The average times and range for initial detection and engagement are shown in Table 26. For Team A, average initial detection time tended to decrease with training, accompanied by a slight increase in range where targets were detected. The same trends appear for initial engagement, although not as strongly. Data for Team B show the same trends. The trends towards earlier detection and engagement at longer ranges may also be a function of changes in tactical behavior on the part of Team A. For example, if Team A moved faster because of training, both teams would tend to enter the action earlier.

Table 27

WEAPON INFLICTING FIRST CASUALTY BY SITE
(TOTAL N = 59)

	Site I	Site II	Site III	Site IV	All Sites	Percent of Total
Tank	2	4	2	1	9	15.3%
TOW	2	1	5	2	10	16.9%
Infantry	4	2	2	2	10	16.9%
Unobserved Fire	5	1	0	11	17	28.8%
Observed Fire	2	6	4	1	13	22.0%
					59	

Data on weapons inflicting the first casualties (Table 27) show that artillery played a critical role in starting the action. Artillery accounted for half the initial casualties, with unobserved artillery accounting for more than half of the artillery casualties. This reflects the effective use of preplanned fires by both teams early in the exercise. Tanks, TOWs, and infantry accounted for approximately the same proportion of initial casualties.

Weapons Effectiveness Data

Because casualties can be realistically assessed during REALTRAIN exercises, weapons effectiveness can also be studied. The following subsections show the percent of casualties inflicted by each weapon type for each major target type -- tank, TOW, APC, and infantry.

Tables 28 through 31 show (by training site and for all sites combined) the percent of "kills" achieved by each type of weapon for tanks, infantry personnel, TOWs, and APCs. Figures 5 through 8 graphically summarize the distribution of casualties according to weapons used for tanks, infantry personnel, TOWs, and APCs.

Table 28, Tank Losses, shows that approximately 50% of the tanks killed across all sites were killed by other tanks; 25% were killed by TOWs; and 25% by a combination of weapons in the hands of the individual foot soldier -- the LAW, 90 mm recoilless rifle (RR), grenades, and the Dragon (at Site I). The TOW was a more effective weapon at Sites II and III, where there was more space and open area than at Sites I and IV. The shorter range 90 mm RR antitank weapon was the more effective weapon at smaller Sites I and IV.

Table 29, Infantry Losses, shows that across all sites 39% of the infantry were killed by other infantry using the M16 or M60 machine gun; almost a third (31%) by artillery; 15% by tanks; and 14% by a combination of other weapons (i.e., LAW, 90 mm RR, TOW, and grenades). There was a higher percentage of infantry casualties at the smaller sites (52% infantry casualties at Site I, 48% at Site IV) than at the larger sites (37% at Site II and 35% at Site III).

Table 30, TOW Losses, shows that the largest percentage of TOW casualties across all sites were from artillery fire (32%); 29% by other TOWs; and about one-fifth by tanks. Infantry using the LAW, 90 mm RR, Dragon, and grenades accounted for 17% of the TOW casualties. At Sites I and IV, tanks accounted for only about 10% of the TOW casualties while at Sites II and III they accounted for approximately one-third of the casualties.

As shown in Table 31, APC Casualties, 33% of the APC kills were from a combination of infantry weapons; 32% by artillery; 30% by tanks; and 5% by TOWs.

Table 28

TANK LOSSES AS FUNCTION OF WEAPON TYPE

	Site I	Site II	Site III	Site IV+	All Sites
Tanks Killed / Tanks Played	53/147 = 36%	69/132 = 52%	51/130 = 35%	46/130 = 35%	219/53[illegible] = 41%
Percent of Kills:					
By Tanks	55%	55%	51%	39%	51%
By TOW	15%	32%	35%	15%	25%
By LAW	0%	4%	6%	9%	5%
By Dragon	15%	--*	--*	--*	4%
By 90mm RR	15%	9%	6%	30%	14%
By Grenade	0%	0%	2%	7%	2%

*Dragon not played.
+Does not include 4th Week.

Table 29

INFANTRY LOSSES AS FUNCTION OF WEAPON TYPE

	Site I	Site II	Site III	Site IV+	All Sites
Infantry Killed / Infantry Played	310/610 = 52%	223/598 = 37%	224/634 = 35%	251/528 = 48%	1008/2361 = 43%
Percent of Kills:					
By M16/MG	41%	32%	41%	42%	39%
By Artillery	36%	24%	28%	34%	31%
By Tanks	1%	17%	26%	15%	15%
By Other Weapons	22%	27%	5%	9%	14%

+Does not include 4th Week.

Table 30

TOW LOSSES AS FUNCTION OF WEAPON TYPE

	Site I	Site II	Site III	Site IV+	All Sites
TOWs Killed / TOWs Played	22/60 = 37%	27/55 = 49%	16/52 = 31%	19/48 = 40%	84/215 = 39%
Percent of Kills:					
By Tanks	9%	33%	31%	11%	21%
By TOW	46%	26%	31%	11%	29%
By Artillery	32%	30%	19%	47%	32%
By 90mm RR & LAW	4%	11%	13%	31%	14%
By Dragon	9%	--*	--*	--*	2%
By Grenade	0%	0%	6%	0%	1%

*Dragon not played.
+Does not include 4th Week.

Table 31

APC LOSSES AS FUNCTION OF WEAPON TYPE

	Site I	Site II	Site III	Site IV+	All Sites
APCs Killed / APCs Played	32/60 = 53%	23/56 = 41%	20/26 = 77%	22/48 = 46%	97/190 = 51%
Percent of Kills:					
By Tanks	25%	30%	35%	32%	30%
By TOW	3%	8%	5%	5%	5%
By Artillery	31%	35%	40%	36%	32%
By 90mm RR & LAW	25%	26%	15%	23%	26%
By Dragon	13%	--*	--*	--*	4%
By Grenade	3%	0%	5%	4%	3%

*Dragon not played.
+Does not include 4th Week.

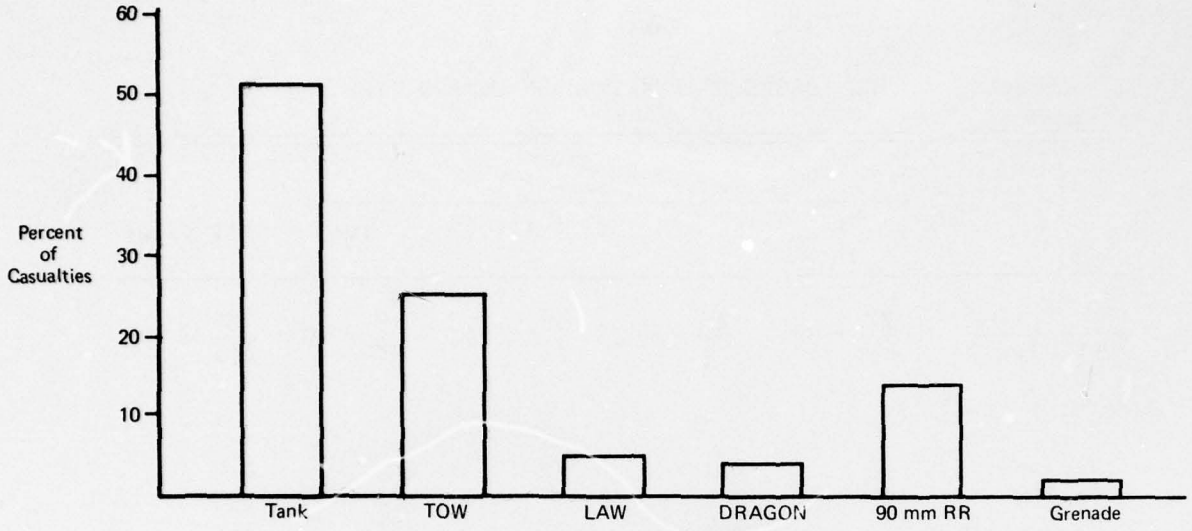


Figure 5: Percent of **Tank** Casualties as a Function of Weapon Type

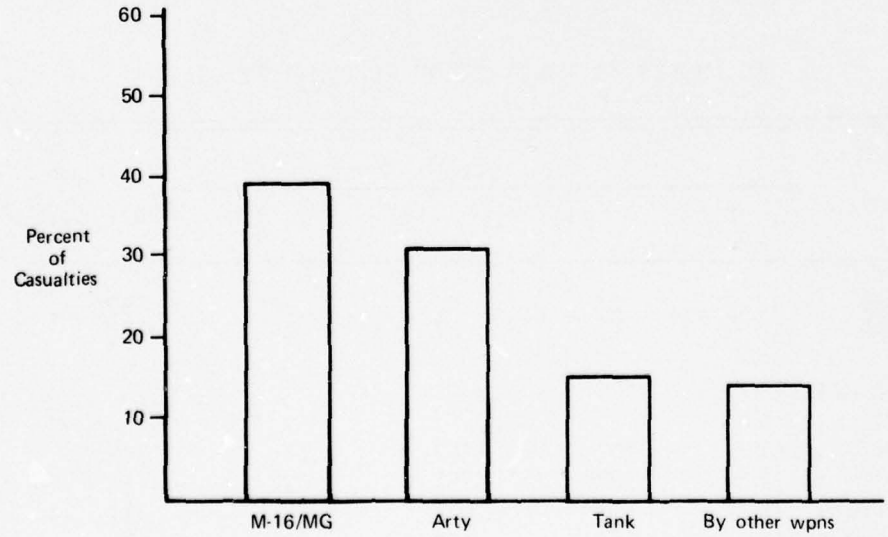


Figure 6: Percent of **Infantry** Casualties as a Function of Weapon Type

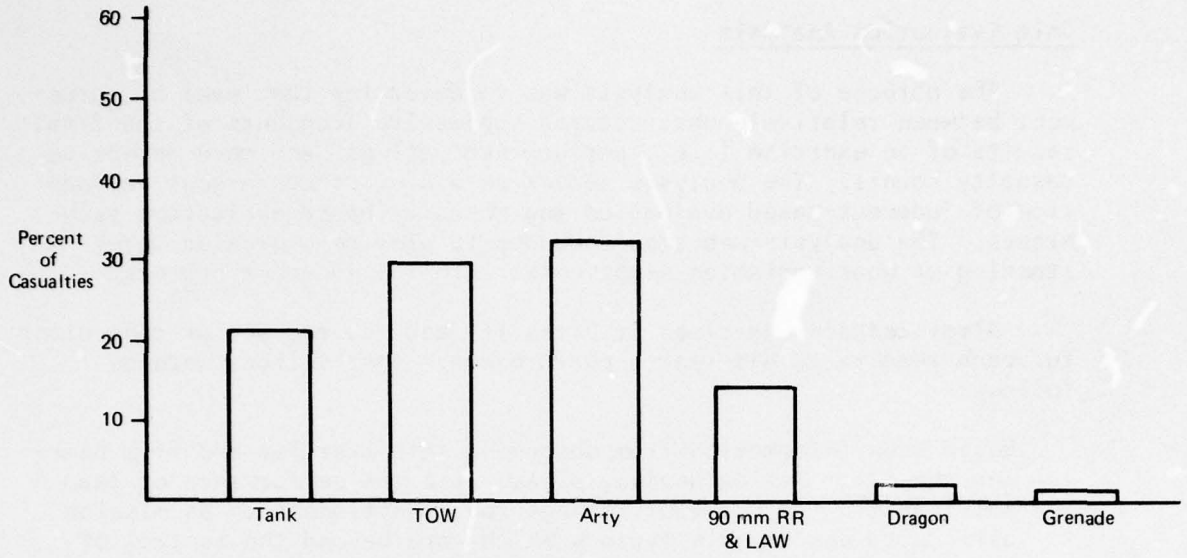


Figure 7: Percent of **TOW** Casualties as a Function of Weapon Type

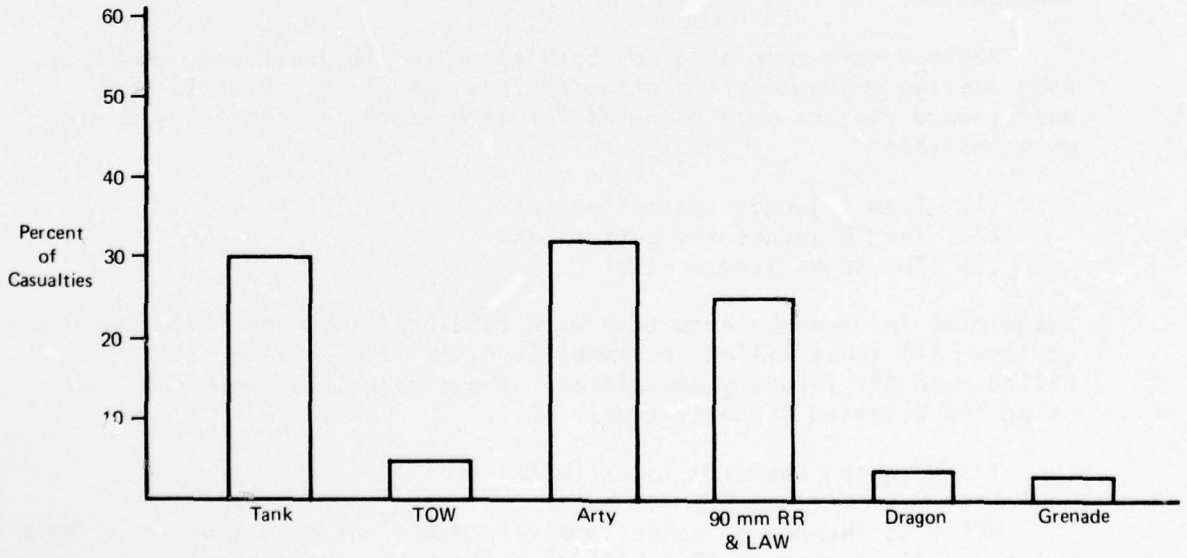


Figure 8: Percent of **APC** Casualties as a Function of Weapon Type

Unit Evaluation Analysis

The purpose of this analysis was to determine the level of agreement between relatively unstructured subjective judgments of the final results of an exercise (i.e., performance ratings) and more objective casualty counts. The analysis serves as a kind of convergent validation of judgment-based evaluation and casualty-based evaluation techniques. The analysis was also intended to provide a greater understanding of what variables might enter into the judgment process.

After certain exercises at Sites III and IV, the senior controller for each team rated his team's performance. Instructions were as follows:

> Based upon information from observing this exercise and from hearing the After Action Review, please rate the performance of Team A (or Team B). Adjust your ratings for conditions such as mission difficulty and terrain factors which were beyond the control of Team A/B, but which may have given Team A/B an advantage or disadvantage. Base your ratings on experience with REALTRAIN exercises. For example, a rating of 1 would indicate that performance on this exercise was like the poorest performance you have observed; a rating of 7 would indicate that performance on the exercise was like the best performance you have observed.

Ratings were made for overall team performance and for the following elements of the team: tank platoon, mechanized infantry squads, and TOW section.

Ratings were completed for both teams for 18 exercises, combining both meeting engagement and attack/defend exercises. Overall team performance ratings were compared for each exercise. Three outcomes were possible:

(1) Team A judged the better team.
(2) Team B judged the better team.
(3) The teams judged equal.

Casualties incurred by each team were tabulated into the following categories: (1) tanks killed or immobilized, (2) TOWs killed, (3) APCs killed, and (4) infantry casualties. These casualties were combined using the Weighted Casualty Index (WCI).

The Weighted Casualty Index (WCI):

WCI = 35 (Number of tanks immobilized/killed) + 25 (Number of TOWs killed) + 15 (Number of APCs killed) + (Infantry casualties)

The WCI was calculated and compared for the teams for each exercise. The lower the WCI, the better the performance.

To determine the relationship between performance ratings and WCI measures, the frequency with which these two variables agreed was calculated. Performance ratings and the WCI agreed for 13 of 14 exercises. Four exercises rated as equal were dropped from the analysis.

The Weighted Casualty Index and performance ratings are relatively gross measures of unit performance. To determine whether more specific measures also showed good agreement, directional agreement relationships were calculated within the performance ratings, within the casualty variables, and between the two. These agreement relationships are presented in Table 32. (Values in the matrix indicate the number of exercises out of 14 in which direction of any two variables agree. For example, the value, 12, for 1 versus 2 indicates that for 12 exercises the team rated higher on overall performance was also rated higher on tank element performance. Given the null hypothesis that the probability of agreement is 50% [i.e., chance], the probability of 11 or more agreements is equal to or less than 5%. Thus, any entry equal to or greater than 11 is significant at $P < .05$.)

The table shows there was a high degree of relationship between ratings of overall team performance and performance ratings for the infantry and armor elements. Ratings of infantry and armor element performance were also in close agreement. Only the performance of TOW elements did not bear a significant relationship to that of other elements of the team or to overall team performance.

Comparison of casualties incurred by the team elements and casualties as measured by the WCI show a similar pattern. Casualties incurred by tank and infantry elements were related to the WCI.

Comparison of performance ratings with objective casualty figures again presents the same pattern. As noted above, overall team performance ratings and the WCI agreed for 13 of the 14 exercises. Relationships of similar magnitude were found for the armor and infantry performance ratings and casualties.

Controller judgments (i.e., performance ratings) of team performance may be seen to bear a strong relationship to a quantitative scoring system combining all casualties (with the highest weight for tank casualties). Thus, there appears to be a measure of convergent validity. However, those factors that may have influenced controller judgements were not measured in this series of exercises. Therefore, it is not possible to say at present to what degree controller judgments were directly influenced by a knowledge of casualties incurred and to what degree by other factors, such as the unit's scheme of maneuver or its employment of indirect fire on the enemy. Further research is required to determine the relative contribution of the various tactical factors potentially influencing the perception of the adequacy of a unit's performance.

Table 32

NUMBER OF AGREEMENTS (OUT OF 14 EXERCISES) BETWEEN PERFORMANCE RATINGS AND CASUALTY DATA

		Performance Rating				Casualties					
		Overall Team 1	Tanks 2	Infantry 3	TOW's 4	Tanks Immob/Kill 5	TOW's Kill 6	APC's Kill 7	Infantry Cas. 8	WCI 9
Performance Rating											
Overall Team	1										
Tanks	2	12									
Infantry	3	13	11								
TOW's	4	7	7	8							
Casualties											
Tanks Immob/K	5	13	12	13	8						
TOW's K	6	5	6	4	5		4				
APC's K	7	7	10	9	9		8	7			
Infant. Cas.	8	13	13	13	9		13	7	7		
WCI	9	13	12	13	8		13	7	7	12	

SUBJECTIVE DATA RESULTS

Two types of questionnaires were administered for the REALTRAIN exercises: A short eight-item Participant Questionnaire for troops participating in the training exercises, and a longer Leader-Controller Questionnaire for controllers or leaders of participant teams. (Questionnaire copies are in Appendix G.) Interviews were also conducted with 10 participants at Site IV. A summary of these interviews is also presented here.

Participant Questionnaire

This questionnaire was completed by 542 participants, 302 with an infantry MOS (56%) and 240 with an armor MOS (44%). The responses to the questionnaire show no systematic or significant differences in responses among sites, teams, armor versus infantry, or respondent rank. Results discuss the replies of all participants therefore without further breakdown. Responses by site, team, and branch (armor or infantry) are shown in Appendix G.

Infantry personnel were asked if they had prior SCOPES training: 53% said that they had, and 45% had not.

When asked about the last time they took Table VIII, armor personnel responded as shown below:

	N	%*
0-4 months	91	38
5-12 months ago	46	19
12 or more months ago	14	6
Never	69	29

Of those who had taken Table VIII, 120 (79%) said they had qualified, 31 (21%) said they failed to qualify.

The responses to the two questions on the perceived state of training before and after participating in REALTRAIN are summarized in Figure 9. The results are very positive in judging REALTRAIN's effectiveness. An interesting finding, not reflected in the figure, was that about 5% of respondents gave their unit a lower rating after REALTRAIN than before. Although this could be construed as indicating that

*Percentages are based upon total questionnaires returned. Omitted items result in percentage totals of less than 100.

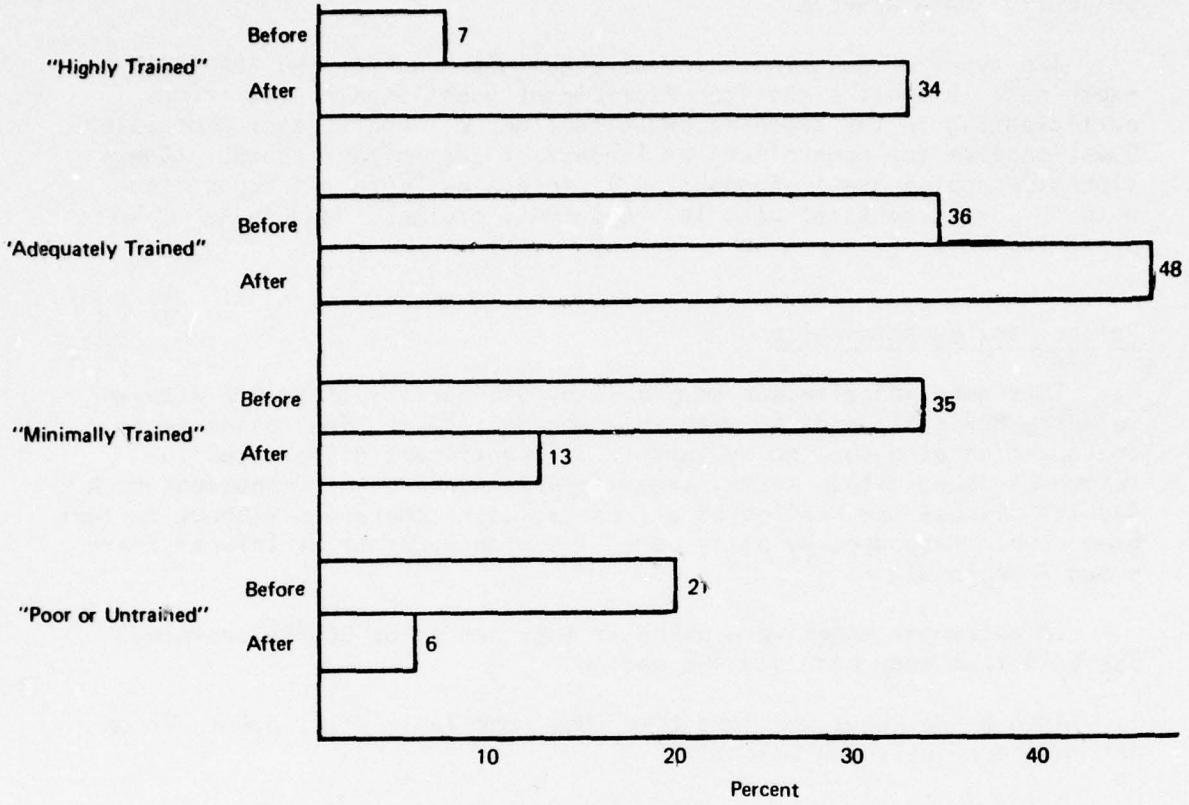


Figure 9: Perceived State of Training Before and After REALTRAIN

the respondents thought REALTRAIN negatively affected unit readiness, a more reasonable interpretation is that the unit's participation in REALTRAIN heightened the respondent's awareness of his unit's shortcomings.

Probably underlying the perceived improvement in state of unit training is that most participants felt that REALTRAIN provided more effective training than normal unit training. When asked how effective they felt REALTRAIN was compared to normal unit training, participants responded as shown:

Much more effective	63%
More effective	21%
Equal	10%
Less effective	5%

One reason for the participants' feeling that REALTRAIN was more effective than normal training could be that 57% felt REALTRAIN similar to combat, 34% felt it similar but with some differences, and only 4% felt there were many differences.

Two questions were also asked about the After Action Review (AAR) conducted after a REALTRAIN exercise. Forty-five percent said they learned much from the AAR; 42% that they gained some information from the AARs. Only 6% felt they got very little from the reviews. In response to the second question on the AAR, 75% said they felt there was something to be learned from the AAR. Fifty-two percent said they got a better understanding of the action. Forty-four percent felt their individual contributions during an AAR were welcomed. Eleven percent said they felt uncomfortable during an AAR when identified as having been a casualty. Negative responses showed that 11% felt they learned nothing and 7% said they felt the AAR was boring.

Leader-Controller Questionnaire

The Leader-Controller Questionnaire was administered to 343 controllers and 38 leaders ranging in grades from E-4 to O-3. Most respondents were in E-6 and 7, O-1 and 2 grades, representing squad and platoon level NCOs and officers.

The questionnaire obtained data about recent unit training experiences other than REALTRAIN, as well as reactions to REALTRAIN. For controllers, it surveyed reactions to their experience. Responses were quite favorable to REALTRAIN. Table 33 shows that REALTRAIN was reported to be more effective than live fire exercises, traditional field exercises, and by-the-number battle drill exercises. Only live fire was compared at all favorably with REALTRAIN's perceived effectiveness.

Table 33

COMPARISON OF REALTRAIN TO OTHER METHODS OF COLLECTIVE TRAINING

REALTRAIN Compared to:	Live Fire	Field Exercise	Battle Drill
is:			
More Effective	77%	97%	94%
About the Same	21%	2%	6%
Less Effective	2%	1%	0%

Infantry and armor personnel responded somewhat differently to the comparison of REALTRAIN and live fire exercises. See Table 34.

Table 34

COMPARISON OF REALTRAIN TO LIVE FIRE EXERCISES BY BRANCH

	Infantry	Armor
More Effective	85%	66%
About the Same	12%	30%
Less Effective	2%	4%

Respondents also indicated that REALTRAIN should be used extensively in a tactical training program, regardless of the amount of time available.

Table 35

PERCENT OF TIME RECOMMENDED TO BE DEVOTED TO EACH TRAINING METHOD

Time Available for Tactical Training:	REALTRAIN Exercise (Mean %)	Live Fire Exercises (Mean %)	Field Exercise (Mean %)	Battle Drill (Mean %)
Adequate	54	22	12	11
Constrained	56	21	11	10

Table 36 shows that 90% of the respondents considered REALTRAIN very effective in training on the use of terrain as cover and concealment; 73% felt it was very effective in training on employment of all available weapons; while 62% felt it was also very effective in training on

employment of indirect fire. A very small percentage of respondents felt it was not effective for the three training purposes.

Table 36

EFFECTIVENESS OF REALTRAIN FOR TACTICAL TRAINING

How effective do you consider REALTRAIN to be for training units to:

	Very Effective	Effective	Not Effective
a. Use terrain for cover and concealment	90%	9%	1%
b. Employ indirect fire	62%	35%	3%
c. Properly employ all available weapons	73%	25%	2%

Two items requested information about the recent training experience and problems of the leaders or controller's own unit. For leaders, the information pertains to the participating units; for controllers, it does not. For this report, a summary analysis of data from these items is in Tables 37 and 38.

Table 37

EXTENT OF PRIOR TACTICAL TRAINING

During the past six months	Mean	SD	Median
a. How many days has average platoon spent on tactical training each month?	9.4	6.6	9
b. How many men in platoon?	20.2	8.7	20
c. How many NCOs?	6.6	2.8	5
d. How many days has your unit spent at major training areas?	39.1	24.4	30

Table 38

CONSTRAINTS TO TACTICAL TRAINING

Rate items from 1 to 5 for impact each has on the tactical training program in your unit (1: great impact, and 5: little impact.)	Mean Rating
Nonavailability of personnel	2.3
Lack of training area	2.6
Lack of POL or ammunition	2.6
Personnel turbulence	3.0
Equipment down	3.2
Lack of NCOs	3.3

One item of the questionnaire requested a listing of the "most important individual and team skills that you think REALTRAIN exercises impart." A second item asked controllers about controller skills that were developed. The responses to these questions are not readily amenable to quantitative treatment. After inspecting a number of questionnaires, however, a coding system was developed. Categories used and the frequencies of responses of each category are shown in Figures 10 and 11.

The wide differences in category descriptions demonstrate the diversity of responses. The more frequently used categories probably reflect the more obvious perceptions of REALTRAIN's use.

Controllers were asked two questions about their experiences. Responses show that 70% of controllers feel that the tactical training value of REALTRAIN exercises was greater for controllers than for a participant. Negative responses to this item tended to come primarily from persons who served as tank controllers. The tank controller has limited opportunity to observe what goes on outside his tank; in the explanation section for this item, 34 respondents mentioned this particular problem.

Functions of Command

Individual Skills:	Team Skills:
1. Judgment under stress	1. Team work (unity)
2. Initiative	2. Judgment under stress, attitude and enthusiasm
3. Team work (unity)	3. Flexibility* Estimate of situations* Planning*

Military Techniques

Individual Skills:	Team Skills:
1. Weapons proficiency	1. Artillery adjustment
2. Artillery adjustment	2. Communication procedure
3. Concealment	3 Weapons proficiency

Tactical Operations

Individual Skills:	Team Skills:
1. Use of cover	1. Combined arms team
2. Movement (maneuver)	2. Movement (maneuver)
3. Tactical principles	3. Mutual support (Overwatch)

*Ties

Figure 10. "Military Skills Imparted to Participants by REALTRAIN": Three Responses Most Frequently Given by Controllers and Leaders

Functions of Command

Individual Skills:	Team Skills:
1. Judgment under stress, attitude and enthusiasm	1. Team work (unity)
2. Knowledge	2. Planning*
3. Team work (unity)*	Judgment under stress, attitude, and enthusiasm*
Estimate of situation*	3. Estimate of situation

Military Techniques

Individual Skills:	Team Skills:
1. Communication procedures	1. Communication procedures
2. Weapons proficiency	2. Artillery adjustment
3. Artillery adjustment	3. Weapons proficiency

Tactical Operations

Individual Skills:	Team Skills:
1. Tactical principles*	1. Tactical principles
Use of cover*	2. Combined arms team
2. Movement (meneuver)	3. Movement maneuver
3. Control	

*Ties

Figure 11. "Military Skills Imparted to Controllers by REALTRAIN": Three Responses Most Frequently Given by Controllers

Table 39

TACTICAL TRAINING VALUE OF REALTRAIN EXERCISES FOR CONTROLLERS

Training value of REALTRAIN exercises for a controller as compared to participants:	
Much greater	34%
Somewhat greater	37%
About the same	15%
Somewhat less	9%
Much less	5%

Almost all controllers felt adequately prepared by their week of training to implement REALTRAIN in their unit.

Table 40

ADEQUACY OF REALTRAIN CONTROLLER TRAINING

(Controllers only) How well has this week prepared you to implement REALTRAIN?	
Completely	12%
Well	55%
Adequately	32%
Not very well	1%
Poorly	0

This questionnaire also included an item on use of SCOPES. Responses are shown in Table 41.

Table 41

SCOPES UTILIZATION

(Infantry only) The following questions concern Squad Combat.

Operations Exercises (Simulation) or SCOPES and the related equipment and exercises:

a. Does your unit have SCOPES equipment?

127 Yes 41 No 7 Don't Know

b. How many days has your unit spent on SCOPES exercises during the past six months?

4.2 Mean 10.6 Standard Deviation

c. How many days do you feel your unit should spend on SCOPES exercises during a six-month period to be prepared for combat?

35.2 Mean 27.9 Standard Deviation

Summary of Participant Interviews

During the fourth week of training at Site IV, a member of the research team conducted ten interviews with representative REALTRAIN participants at Site IV. The participants interviewed were from both the A and B Teams and included armor, infantry, and controller personnel. Several levels of command structure were represented (platoon leader, tank commander, staff sergeant, platoon sergeant, enlisted). The interviews were carefully analyzed and many items of information emerged, several going beyond the scope of the interview questions. Generally, the analysis supports the data collected in the Participant and Leader/Controller Questionnaires.

The following response categories are those which seemed to be most relevant in evaluating REALTRAIN. Representative responses are included.

Sense of Survivability on the Battlefield. There was very strong feeling by all interviewees that their sense of personal and team survivability was markedly enhanced by REALTRAIN-training.

> I am a combat vet. Most of the guys out here didn't have any idea about it, not in my squad. But right now they know what's involved

and they are keeping their heads down, their tails down, they're moving fast and they're moving right. They are working as teams. (Staff Sgt, Inf [A Team].)

In REALTRAIN you see your mistakes and talk about them. Why did I get killed? Why did that TOW see me? How did this infantryman get on top of my track and throw a grenade inside? You can see it and you know your mistakes, and very rarely do you make the same one twice. (Staff Sgt, Armor [B Team].)

Cooperative and Individual Learning. There was extensive learning about the need for each team to work well together, and for close teamwork among different teams to accomplish the unit's mission. This was the primary learning experience noted in all of the interviews.

I think the major thing they've learned is to work with the combined arms. They've learned how to work with infantry. They've learned the infantry weapons and how to use them. They've learned how to use artillery and more important than that, they've learned how to work as a team, rather than as an individual tank. When we first came out here, we'd get in a battle and it would be just your tank against another and you'd find yourself another one. Now we are working as a real combined arms team. (Staff Sgt, Armor [A Team].)

Really how to work together. They are learning the basics, the importance of the basics, especially with fire and maneuver. I think they are starting to learn they are needed to survive, and they are also learning to work with tanks, how to clear for tanks, scoping on tanks. (Lt, Inf [A Team].)

I think that most tankers have been aware of the theory but this is the first time they've really had to try it, really work together, and I think it has made the tankers think a lot more about the value of the infantry as a tank killer team. They've never really been faced with the possibility of the infantry coming in with a couple of LAWs and knocking them out before. (Staff Sgt, Armor [B Team].)

Cross Training. As a component of learning cooperation, team participants also learned substantial new individual skills. A good example is cross training--developing individual skills outside of the soldier's MOS. (This result highlights the possible need to consider cross training across branches at the small unit level.)

Another thing is cross training. If you took the tankers, take them out of their tanks and work with the infantry and inversely take the infantry and put them with the tankers so that they have got an idea, I'd take some of my people, we'd know how to gun, we'd know how to work a tank. That way if you get into a situation on the battlefield (I have seen it before) you knock out the tank but the

equipment is still good. You could turn around and tear some tail loose with it. (Corporal, Inf [A Team].)

Motivation. The trainees became highly motivated through REALTRAIN practice, as judged by their peers and superiors, and attested to by the participants themselves. Their motivation was enhanced by the realism of the exercise, the spirit of competition, the precise feedback response to hits and kills, and the sense of personal competence that evolved from the learning experience. This motivation was further supported by their comments on morale.

> The most outstanding thing about REALTRAIN is that you see the effects of your work. You have an idea of how good you're doing, how well you are moving, because people are being placed dead once you get a good shot on them and they are out of the problem. Therefore, when you shoot a person, he's dead, you can advance. Without it you would be firing all day long and no one is going to be out of the problem. With the combined arms it's really good because you get to work against tanks, get a kill on tanks, and you know you are doing something. You see the effects of your work and that is what you need. (Lt, Inf [A Team] .)

> You wonder how in the world can you get killed. In the (After Action Review) you find out that a TOW was sitting way up on another hill, well within its range and just got you 'cause you got out in the open. (Lt, Armor [B Team] .)

Morale. As with many training exercises, the initial attitude by the troops to REALTRAIN in its beginning steps was unenthusiastic. Morale seemed low, with little desire to go slogging around in the mud and the snow "playing soldier." Significantly, however, as the training proceeded, there was a rapid shift to a high state of morale once the participants became aware of the reality of the training.

> They want to stay another month. Since we began training, I've had a total of three sick calls and those were because of the flu epidemic. My appointments are just emergency type things. Accountability and morale is 100 percent. It has been beautiful. (Staff Sgt, Armor [A Team].)

> The first week it was sort of low; the second week we got our stuff together and got the tanks working. Since then, it's been higher than a kite and it stays that way. (Staff Sgt, Inf [A Team].)

REALTRAIN Evaluation. REALTRAIN was felt to be superior to all other types of training previously received, and to be more applicable to probable situations in real combat. It taught the need for a practical integration of separate skills which, until this time, had only been brought together theoretically in the tactician's mind.

> I say it's the best training I've seen since I have been in the Army. It just can't be compared with anything else. (Staff Sgt, Armor [A Team].)

> Compared to gunnery training to use the gun, you have to know to maneuver the tank first. Tactics are moving the tank and learning how to spot the enemy. Before REALTRAIN we drove all over the countryside and never were able to kill the enemy. Now it's pretty exciting. (Corporal, Armor [A Team].)

Areas of Need. Two types of problem areas were identified from the interviews. One was related to suggested improvements in REALTRAIN; the second was concerned with problems of conducting effective REALTRAIN training in units.

With respect to REALTRAIN improvements, 50% of the interviewees were less than happy with hit accountability. The time required to confirm hits on vehicles was felt to be less than realistic. It was also felt that improved methods for identifying when vehicles or personnel had been killed were required, because the current system sometimes makes it difficult to recognize a "dead" target. Several participants suggested that additional controllers and better marking procedures would help resolve this particular issue.

> There are too many times when you're on the ground, going through the woods and you hear a tank in front of you, it's running--a lot of times you don't even turn off the motor. You hear it in front of you, you are not too worried, there's that little red flag, you are not going to be able to see it. You are going to move up and you want to get it before it gets you, and therefore you are trying to look for the number and you are moving up toward it. You throw one green smoke grenade and that thing's gone in a matter of minutes and you come up 5 minutes later and you run across it; you don't know if it's alive or dead. Plus, you have to control people who are dead, to remain dead, take off their helmets, sit down and be out of the problem for good. (Lt, inf [A Team].)

The After Action Reviews were felt to be shortchanging the infantry and their individual kills by concentrating on tank and TOW casualties. This deficiency reduced the sense of achievement by infantry personnel, which is critical to the learning intended to take place in the exercises. The problem results in part because of insufficient time available when the After Action Review is conducted with a large group.

In regard to problems of unit training, many of those interviewed expressed a general belief that additional time would be required to bring their units up to a state of tactical readiness. Fifty percent of the respondees felt that additional training would be required for a matter of weeks. Only two said their units were ready now.

Overall Effectiveness. In summary, the interviews provide a real sense of the direct involvement by the troops in REALTRAIN. There is one eloquent comment that seems to say it all:

> It's the next thing to combat except that you don't get killed. If it excites the privates, it's got to excite you. (Platoon Sgt, Armor [B Team].)

LOGISTICAL DATA

To help provide an estimate of the cost of conducting REALTRAIN exercises, detailed records were kept on:

(1) engine hours and miles driven for the various vehicles used in such exercises; and

(2) ammunition expended.

Vehicle Data

Table 42 presents a summary of the miles traveled and engine hours. These are weekly averages by site, across all sites. During a typical week, five combined arms exercises and two armor-only (or infantry-only) "mini-exercises" were conducted. For the infantry-only "mini-exercises" the APCs were not used; the figures for APCs are thus for the five REALTRAIN combined arms exercises only. POL data are not presented because valid figures were not available, primarily because most POL tank trucks did not have fuel gauges. Control jeep mileage at Site IV is not presented because vehicles were frequently substituted during training weeks.

Table 42

AVERAGE MILES TRAVELED/ENGINE HOURS BY TYPE OF VEHICLE, PER WEEK, AND SITE

Type of Vehicle	Site I		Site II		Site III+		Site IV		All Sites	
	Miles	Hours	Miles	Hours	Miles	Hours	Miles	Hours	Miles	Hours
Tank	19.2	9.3	43.8	9.9	15.4	7.8	10.7	5.2	22.3	8.1
APC/TOW	17.5	7.9	43.5	10.9	28.5	5.3	10.6	4.6	25.0	7.2
APC	19.2	5.4	52.5	6.9	23.3	5.3	9.4	4.8	26.1	5.6
Control Jeep	82.0	-	143.6	-	112.3	-	-*	-	112.6	-

+Based on one week.
*Data not available.

Ammunition Expenditure Data

Ammunition expenditure data are presented in two tables. The first, Table 43, presents actual recorded ammunition expenditure. These results are somewhat suspect, however, because of problems in collection of precise data and in unprogrammed expenditures (e.g., "firing up" remaining rounds at end of a training week). Using ammunition expenditure data collected at the first two sites, military personnel thoroughly familiar with REALTRAIN developed the refined per-exercise estimate presented in the second table, Table 44. (The number of projected exercises to be conducted annually for each platoon and the number of rifle, tank, and TOW platoons in USAREUR were provided by DCSOPS, USAREUR.)

Table 43

ACTUAL AMMUNITION EXPENDED (ON A PER EXERCISE BASIS)
DURING REALTRAIN IMPLEMENTATION IN USAREUR

CoDAC Nr.	Description	Average Per Exercise Quantity
1305 A080	Cartridge 5.56-mm blank	1179
1305 A111	Cartridge 7.62-mm blank linked	1366
1305 A559	Cartridge 50 Cal Blank M-1	242
1320 G811	Hand Grenade Practice	20
1320 G850	Hand Grenade Charges	40
1320 G878	Hand Grenade Fuze	40
1330 G930	Grenade Hand Smoke (HC)	21
1330 G940	Grenade Hand Smoke (Green)	20
1330 G945	Grenade Hand Smoke (Yellow)	4
1330 G950	Grenade Hand Smoke (Red)	1
1330 G955	Grenade Hand Smoke (Violet)	3
1340 H557	Rocket HE 66-mm M72 LAW (expended)	3 per squad
1345 K051	Fuze Mine Practice, M-604	6
1345 K144	Practice Claymore (Inert)	Not available
1345 K231	Mine Antitank Practice Heavy M20 w/o Fuze	1
1345 K866	Smoke Pots HC M-5	2
1370 L279	Signal Illumination (White Star)	3
1370 L366	Simulator Projectile Air Burst	13
1370 L594	Simulator Projectile Ground Burst	63
1370 L598	Simulator Booby Trap Flash M117	1
1370 L601	Simulator Hand Grenade	31
1375 M130	Cap Blasting Electric Special	6
FSN 1345-011-3260	Tripwire	Not available
FSN 1337 168-5610	Blast Diaphragm Simulator (TOW)	16

NOTE: Ammunition amounts are based on two (2) tank platoons, four (4) mechanized rifle squads, and two (2) TOW sections.

Table 44

ESTIMATED AMMUNITION REQUIREMENTS FOR REALTRAIN

SUMMARY

1) Ammunition amounts are for one exercise and are based on four mechanized rifle squads, two tank platoons, two TOW sections.

2) Generally, two platoon level exercises can be conducted by a company commander in one day.

3) Projected exercises to be run annually in USAREUR are based on 234 rifle platoons, 189 tank platoons, and 26 TOW platoons.

4) Estimate each platoon will conduct 12 REALTRAIN exercises each year.

DoDAC Nr.	Description	Exercise Quantity	Total USAREUR Aggregate
1305 A080	Cartridge 5.56-mm blank	200	280,000
1305 A111	Cartridge 7.62-mm blank linked	1000	1,250,000
1305 A559	Cartridge 50 Cal Blank M-1	100	140,000
1320 G811	Hand Grenade Practice	3	4,200*
1320 G878	Hand Grenade Fuze	20	28,000
1330 G930	Grenade Hand Smoke (HC)	10	12,500
1330 G940	Grenade Hand Smoke (Green)	20	25,000
1330 G945	Grenade Hand Smoke (Yellow)	2	2,800
1330 G950	Grenade Hand Smoke (Red)	1	1,250
1330 G955	Grenade Hand Smoke (Violet)	2	2,200
1345 K051	Fuze Mine Practice, M-604	4	5,000
1345 K144	Practice Claymore (Inert)	6	8,400**
1345 K866	Smoke Pots HC M-5	1	1,250
1370 L278***	Signal Illumination (Red Star)	2	2,500
1370 L279***	Signal Illumination (White Star)	2	2,500
1370 L280***	Signal Illumination (Green Star)	2	2,500
1370 L594	Simulator Projectile Ground Burst	100	125,000
1370 L601	Simulator Hand Grenade	20	25,000
375 M130	Cap Blasting Electric Special	3	4,200
FSN 1337 168-5610	Blast Diaphragm Simulator (TOW)	10	2,000
FSN 1345-011-3260	Tripwire	50 Ft	70,000 Ft
N/A	Simulator Round, Hoffman Device	30	22,000

Table 44 (continued)

ESTIMATED AMMUNITION REQUIREMENTS FOR REALTRAIN

*Replace factor is 1 to 6.

**Basis of issue is 6 (mines, M4 cap, M57 device and tester) per platoon for a one-time requirement.

***Signal requrements are for one of each color per exercise. May be any type illuminating or smoke signal. Initial issue of pengun flares must be L116 and L117 signal kits to obtain the projector.

OBSERVATIONS ON REFINING REALTRAIN

Overview: One of the stated objectives of the research team during implementing REALTRAIN in USAREUR was to obtain information and insights related to the refinement of the REALTRAIN method. REALTRAIN has already been accepted as an effective method of tactical training, filling a previous void. The opportunity provided by the REALTRAIN/USAREUR implementation was expected to provide valuable new inputs for the refinement of REALTRAIN: to improve its effectiveness as a method of tactical training and the efficiency with which such exercises could be planned, conducted and reviewed.

The data presented above suggest areas for REALTRAIN refinement. The observations of members of the research team (who were on-site during the conduct of REALTRAIN exercises) can also provide insight into areas where REALTRAIN may be refined and improved.

The emphasis in the following discussion is on the training value of the method and is not concerned with problems of logistics or casualty assessment techniques.

Planning Training to Overcome Observed Performance Deficiencies

The concern here is with the role of the trainer and the training manager in planning a program of tactical training to achieve certain training goals, not with the planning of a given REALTRAIN exercise.

Performance deficiencies in a REALTRAIN exercise are usually evident after an After Action Review is completed. The problem for the trainer and training manager then becomes one of providing the further training necessary to overcome these deficiencies. The performance deficiencies noted may be of at least three types:

(1) by junior leaders (lieutenants and senior NCOs);

(2) by subunits/teams in the execution of battlefield techniques; and

(3) by unit/team members in individual skills.

Trainers and training managers must be able to recognize such training deficiencies and, more importantly, must know how to overcome them. They must be able to plan further REALTRAIN exercises (by proper selection of mission, terrain, and weapon systems to be employed) to overcome these deficiencies. In the future, attention should be placed on the identification of related training techniques to supplement REALTRAIN exercises. Junior leaders should probably work out some of their problems using sand tables or board games. Subunits/teams must be provided the opportunity for actual practice of techniques that must be carried out almost reflexively on the battlefield--i.e., overwatch or communications procedures. Individual performance can often be improved effectively in the field by informal training by a more experienced individual.

REALTRAIN provides combined arms training to teach infantry, armor, and anti-armor personnel to work together. REALTRAIN implementation in USAREUR showed that in addition to training on their own weapons and tactics, men from each of these three elements should be cross trained on other weapons in the combined arms team. As an example, when his tank was immobilized, a tank platoon leader dismounted and assumed an infantry role. When given a chance to "fire up" an enemy tank, however, he missed it because he did not know how to fire a 90 mm. recoilless rifle. More extensive cross-training among units would elminate such deficiencies.

Terminating an Exercise

During the implementation of REALTRAIN in USAREUR, field exercises were generally allowed to continue until one side was all but wiped out. This procedure was followed to provide maximum training for student controllers in casualty assessment methods and procedures. Exercises in tactical training of troops are similarly allowed to run until very few men are left on one or both sides, in this case to provide troops more exposure to the tactical battlefield. This approach may be counterproductive and teach certain bad habits. Future research must study the desirability of terminating exercises at the point when a prudent commander would withdraw or call in reserve forces, or terminating only the later problems in a series of REALTRAIN exercises after the basics have been learned.

Controller Debriefing

The MTT found early in REALTRAIN/USAREUR implementation that, because of the size of the units involved in the REALTRAIN exercises, there were problems in keeping an accurate and complete Net Control Sheet. This problem, in turn, led to After Action Reviews where the training impact was reduced. The MTT therefore instituted what came to be known as a Controller Debriefing, where all controllers were brought together at the end of an exercise. Using the Net Control Sheet, the senior controller would go over each kill in turn, finding out as much as he could about it, and clearing up any inconsistencies and omissions in the Net Control Sheet. This debriefing normally took 20-30 minutes. The Senior Controller would then conduct the After Action Review. Experience showed that, as a result of the Controller Debriefing, the quality of the After Action Review was greatly improved. The effectiveness of this additional step in the conduct of REALTRAIN exercises should be further analyzed and documented.

Net Control Procedures

While the controller debriefing resulted in an improved After Action Review, further improvements can also be made by a thorough review and analysis of net control procedures. Problems were encountered in recording casualties on the Net Control Sheet when there was moderate-to-heavy action on the REALTRAIN battlefield. Casualties called in were missed, recorded information was incomplete, or kills were attributed to the wrong person or weapon system. Because of the critical importance of an accurate and complete Net Control Sheet for a successful After Action Review, procedures for calling in and recording casualties must be improved.

After Action Review

Observations during the REALTRAIN/USAREUR implementation showed that the quality of the AAR could vary considerably, based on how it was conducted. Student controllers often had difficulty conducting the AAR properly and on several occasions tended more to conduct a critique of specific tactics than a learning session on attempted actions and consequences.

There are problems with the current technique of employing the Net Control Sheet to address casualties in chronological sequence. First, this approach emphasizes the casualties incurred and errors made that led to becoming a casualty. The correct behavior that produced the casualty for the side firing is seldom brought out or emphasized equally during the AAR. Second, the chronological sequence produced by the Net Control Sheet has gaps in time that are seldom considered. The events that occurred during these time gaps might be positive behaviors that led to mission accomplishment or produced enemy casualties.

During the AAR more emphasis is needed on team play and tactics, rather than devotion almost exclusively to individual actions.

APPENDIXES

		Page
APPENDIX A.	REALTRAIN USAREUR MTT Program of Instruction (POI)	75
B.	Data Collection Schema	81
C.	Sample REALTRAIN Exercise	83
D.	"Rules of Engagement"	89
E.	Summary of Casualty Data by Training Site and Week of Training	95
F.	Communications Analysis	103
G.	Questionnaires and Participant Questionnaire Data	113

APPENDIX A

REALTRAIN USAREUR MTT
REALTRAIN POI

DAY 1

1 Hour	Introduction to REALTRAIN (Lecture/Demonstration) Introduction, Demonstration (TV Tape), History of methodology, characteristics, advantages, limitations, outline of POI
3 Hours	Introduction to Controller Duties and Equipment (Practical Exercise) Familiarization with controller duties to include casualty assessment procedures and weapons signature effects. Installation of REALTRAIN equipment. Cadres broken down in following groups for this instruction: Tank Controllers Infantry Controllers Anti-Tank Controllers Indirect Fire Controllers
1 Hour	Lunch
1 Hour	REALTRAIN Rules of Engagement (Lecture) Demonstration) Familiarization with direct and indirect fire rules of engagement.

Preceding page blank

4 Hours	REALTRAIN Exercises (Practical Exercise) Series of short two-sided free play exercises. Infantry squads will work against each other in a dismounted role (attack/defense). Tanks and TOWS opposed each other in meeting engagements in a separate area. Students acted as team/crew controllers.

DAY 2

1 Hour	Review of Control Procedures. (Conference) Review of all control procedures for REALTRAIN exercises. Discussion of problems encountered in field exercises conducted the previous day.
3 Hours	REALTRAIN Exercises. (Practical Exercise) Continuation of short duration exercises (Infantry versus Infantry (Squad level)). (Tanks versus TOWS). Students served as team/crew controllers.
1 Hour	Lunch

4 Hours	REALTRAIN Exercises (Practical Exercise) Continuation of short duration exercises (Infantry versus Infantry (platoon level)). (Tanks/TOWS versus Tanks/TOWS). Indirect fire integrated in test exercise. Students acted as team/crew controllers.

DAY 3

1 Hour	Duties of Senior Controller, Introduction of Indirect Fire and Combined Arms Operations (Lecture, Demonstration) Dual role of commander/senior controller, supervision of control net, recording of casualties, overview of indirect fire procedures, organization of combined arms exercises.
1 Hour	Introduction to After Action Review (AAR) (Lecture, Demonstration) Understanding of the importance of the AAR. Familiarization with the techniques of conducting an AAR.
3 Hours	REALTRAIN Combined Arms Exercise (Practical Exercise) Each combined arms team given a frag order for movement to contact which will result in a meeting engagement or attack/defense. Selected students observed the senior controller role and operation of the Net Control Station. Remaining students served on team/crew controllers.

1 Hour	Lunch
3 Hours	REALTRAIN Combined Arms Exercise (Practical Exercise) Each combined arms team given a frag order for movement to contact which will result in a meeting engagement or attack/defense. Selected students observed the senior controller role and the operation of the Net Control Station. Remaining students served team/crew controllers.
1 Hour	Review of REALTRAIN Control Procedures (Conference) Review of control procedures for REALTRAIN combined arms exercises. Discussion of problems encountered.

DAY 4

3 Hours	Preparation for REALTRAIN Combined Arms Exercise (Practical Exercise) Units will be organized into combined arms teams. Each will be given a delay mission with mines and indirect fire support. Each team will recon, organize and prepare their delay positions. Selected students operate as senior controllers and the net control station. Remaining students will act as team/crew controllers.

1 Hour	Lunch
4 Hours	REALTRAIN Combined Arms Exercises (Practical Exercise) Each delay position prepared prior to lunch will be attacked in turn. Two attack/delay problems will be conducted. Students will remain in the same positions indicated for the preparation phase.
2 Hours	Planning a REALTRAIN Exercise (Conference) Selected students will be familiarized with considerations for planning and preparing a REALTRAIN combined arms exercise. This will include training objectives, administrative and logistical support, unit, terrain and controller requirements. These students will then plan a combined arms exercise to be conducted the following day.

DAY 5

4 Hours	REALTRAIN Combined Arms Exercise (Practical Exercise) This exercise will be planned, prepared and conducted by student cadres.
1 Hour	Lunch

2 Hours	Course Review and Critique (Conference) All instructor personnel and student cadres will discuss the entire scope of REALTRAIN techniques. Students will be requested to provide feedback for improving the course.
2 Hours	Clear Training Area and Departure.

APPENDIX B

DATA COLLECTION SCHEMA

	INSTRUMENT	WHEN COLLECTED	HOW COLLECTED	NATURE OF DATA	REMARKS
DIRECT MEASURES	Net Control Sheet (Casualty Record Sheet) (Form A)	a. During each exercise b. After each exercise	a. Radio Net b. Controller debriefing and AAR	a. Casualties b. Cause of casualties	Revised slightly for Sites III & IV
	Exercise Diagram (Form A')	During and after each exercise	Observation and interview	Diagram of engagement	
	Artillery Control Sheet (Form B) Artillery Control Sheet (Short Form, Form B')	During each exercise	Radio Net	Indirect fire usage	Revised slightly to the shorter form
	Exercise Narrative (Form C)	During each exercise	Observation, interview, and radio net	Narrative description of engagement	
	Tactical Data Supplement (Form D)	During and after each exercise	Observation, interview, and radio net	Critical performance parameters	Revised slightly for Sites III & IV
	Communications Record (Form G)	During each exercise	Radio Net	Tactical radio messages by time	Rough format Sites I & II Form G at Sites III & IV
	Exercise Rating (Form I)	After each exercise	Controller completion (later interview)	Subjective judgement of participant performance	Revised from controller completion to taped interview
	Unit Performance Assessment Model (UPAM) Data (Form K)	After selected exercises	Observation and interview	Evaluation of unit tactical performance	Revised after Sites I & II
	Controller Exercise Record (Form K, part 1)	After selected exercises	Controller completion	Evaluation of unit tactical performance	Sites III & IV Only
	Team Performance Evaluation (Form M)	After each exercise	Controller completion	Subjective judgement of participant performance	Sites III & IV Only
	Major Event Record (Form S)	During and after each exercise	Radio Net, Controller debriefing, and AAR	Significant tactical actions	
	Meeting Engagement Mission Achievement Standards (Form T1)	Before selected exercises	Selected MTT member completion	Minimum acceptable tactical achievement	Sites III & IV Only
	Meeting Engagement Mission Cost Standards (Form T2)	Before selected exercises	Selected MTT member completion	Maximum acceptable tactical cost	Sites III & IV Only

APPENDIX B (cont'd)

DATA COLLECTION SCHEMA (continued)

	INSTRUMENT	WHEN COLLECTED	HOW COLLECTED	NATURE OF DATA	REMARKS
INDIRECT MEASURES	Participant Questionnaire (Form F)	After each training session	Participant completion	Opinions of REALTRAIN	
	Attitude Survey (Form H)	Before and after each training session	Participant completion	Biographical and Attitudinal data	
	Leader/Controller Questionnaire (Form R)	After each training session	Leader/Controller completion	Opinions of REALTRAIN	
COST DATA	Tactical Vehicle Mileage (by Exercise) (Form J)	Before and after selected exercises	Vehicle gauge inspection or driver interview	Vehicle hours and mileage	Sites I & II Only
	Controller Exercise Record (Form K, Part 2)	Before and after each exercise	Controller completion	Vehicle hours and mileage	Sites III & IV Only
	Ammo Usage Tabulation Sheet (Form L)	After each training session	Ammo NCO completion	Ammunition expended by day and week	
	Tactical Vehicle POL Record (Form M)	After each training session	Tactical vehicle driver completion	Gallons of POL added when refueling	Not utilized
	Control Vehicle Usage Record (Form N)	After each training session	Control vehicle driver completion	Vehicle mileage and fuel added	
	POL Weekly Tabulation Sheet (Form O)	After each training session	Driver Interview	Gallons of POL added	
	Mileage Record Sheet (Form P)	Before and after each training session	Vehicle gauge inspection or driver interview	Vehicle hours and mileage	Slightly revised after Site I
REALTRAIN REFINEMENT	After Action Review (AAR) Record (Form E)	During each After Action Review	Observation	Quantity/Quality of participation	
	AAR Analysis Form (Form E')	During each After Action Review	Observation	Quantity/Quality of participation	Sites I & II Only
	Claymore Questionnaire (Form G)	During and After selected exercises	Observation and interview	Effectiveness of different simulations	Not Utilized
	Claymore Simulators Observation Record (Form Q)	During and After selected exercises	Observation and interview	Effectiveness of different simulations	Not Utilized

APPENDIX C

EXERCISE NARRATIVE

EXERCISE NO. 233

DATE: 18 December 1975

WEATHER CONDITIONS: Clear 25 degrees with gusty winds

TERRAIN DESCRIPTION:

The exercise lane was approximately 3000 meters long, 1800 meters wide. Terrain was generally open and rolling with patches of woods and a few dominating hills. Checkpoints were selected throughout the area:

(1) QUEBEC--a small knoll in the northwest sector of the lane.

(2) UNIFORM--another knoll, north and slightly east of QUEBEC.

(3) Large wooded area--extended throughout the northern section of the lane, east of both knolls.

(4) TANGO--a hill mass covered with woods South of QUEBEC.

A north-south road ran generally from UNIFORM south past TANGO to an east-west boundary road on the south of the exercise lane.

(5) SIERRA--a small wooded hill east of the north-south road, slightly north of TANGO.

(6) Base of a wooded ridge--ran from SIERRA south to the road junction on the west side of the north-south road.

(7) FOXTROT--east of the road junction, the most dominant terrain feature in the exercise lane.

(8) Ridge --ran north from FOXTROT to the northern woods intersecting the woodline east of SIERRA.

(9) MIKE--a benchmark near the woodline, further east from this juncture.

(10) OSCAR--a road junction of two roads about 500 meters from MIKE, running generally north-south and constituting the eastern boundary.

TEAM A PLAN:

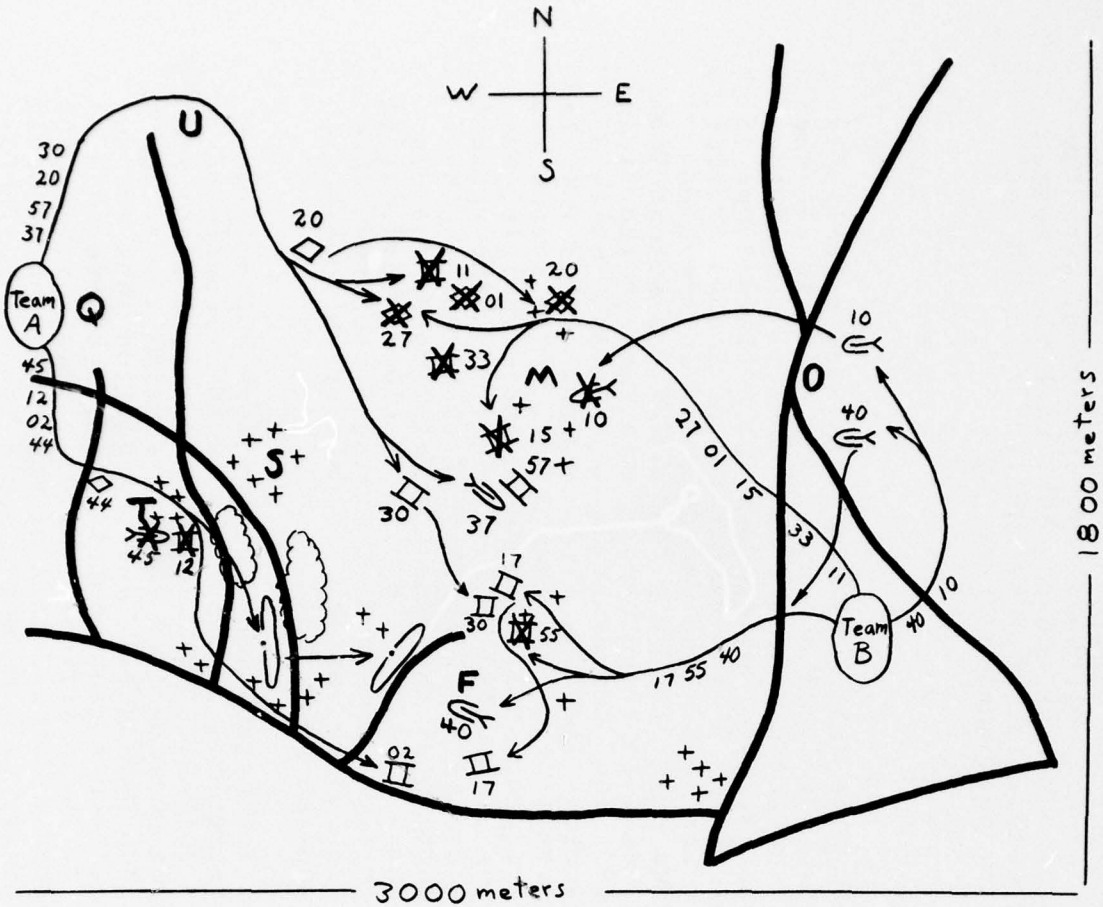
Team A consisted of four tanks, two TOWs and two infantry squads mounted in armored personnel carriers. The Team A assembly area was located in the vicinity of checkpoint QUEBEC. Its general mission was to attack and seize an objective in the vicinity of the road junction in the extreme southeast corner of the lane.

Team A was organized into two combined arms elements. The first, under the direction of the tank platoon leader, consisted of two tanks, a mounted infantry squad, and a TOW vehicle. The infantry platoon leader was to start at QUEBEC, move through TANGO, and continue toward the road junction southwest of FOXTROT. The tank platoon leader was to start in the vicinity of UNIFORM, move to the woodline north of MIKE, consolidate in the vicinity of MIKE, and drive on towards the objective. Smoke was planned in the movement east of the SIERRA-FOXTROT line.

TEAM B PLAN:

Team B consisted of five tanks, two TOWs, and two infantry squads mounted in armored personnel carriers. The Team B assembly area was located approximately 500 meters south of checkpoint OSCAR. Its general mission was to attack and seize an objective in the vicinity of the road junction south of checkpoint QUEBEC.

Both infantry squads, mounted in their vehicles, and followed by the tank heavy section consisting of three tanks were to move north to checkpoint OSCAR and and then turn west and follow the northern boundary through checkpoints MIKE and SIERRA to the objective. The light section of two tanks was to move along the southern boundary and set up overwatch positions in the vicinity of checkpoint FOXTROT. The TOWs were to set up initially near the assembly area and follow by bounds, overwatching the movement of the rest of the team.



EXERCISE DIAGRAM

(Exercise 233,
18 December 1975)

LEGEND FOR EXERCISE DIAGRAM

- Assembly Area
- 45 37 REALTRAIN Vehicle Numbers
- Route of Movement
- Squad Position
- M60A1 Tank
- M113A1 Personnel Carrier
- TOW
- Vehicle Destroyed
- Artillery Concentrations
- Smoke
- F S Map Checkpoints
- Roads

OUTCOME:

The outcome of this battle was a clear victory for the A Team. At the conclusion of the battle, all B Team vehicles and personnel were destroyed, with the exception of one tank and one TOW, with the A team suffering casualties to just one tank, one TOW and one infantry personnel carrier.

DISCUSSION:

Team A. The Team A plan was executed essentially as planned. The first action of the exercise was the successful engagement by a Team A tank of one of the Team B tanks sighted moving down the western slope of checkpoint MIKE. A Team B infantry personnel carrier carrying a complete squad was detected in the same vicinity and destroyed by a Team A TOW. A second Team B tank was also detected by a Team A tank in the vicinity of MIKE. Good coordination by the tank, which did not have a clear field of fire, and one of his TOWs led to the destruction of the Team B tank. The second Team B infantry squad, still mounted in their vehicle, was destroyed by dismounted Team A infantry in the vicinity of checkpoint SIERRA. The final Team B tank in the northern section of the lane was detected by the dismounted Team A infantry. Employing close coordination between two fire teams and utilizing a captured radio, the Team A infantry was able to destroy this tank with two LAWs and one 90mm round.

The action began along the southern boundary when Team A detected the Team B tanks in the vicinity of checkpoint FOXTROT. Artillery was called and adjusted, immobilizing one tank and causing several casualties to dismounted personnel. The immobilized tank was detected by a Team A tank, but it could not move into an unexposed firing position. Therefore, infantry support was requested and the Team A dismounted infantry squad in the vicinity of MIKE moved south towards FOXTROT. Coordinating with their tank, the Team A infantry was able to destroy the immobilized Team B tank with LAW and 90mm fire. In the course of this engagement two Team A infantrymen were hit by tank fire.

The Team A element, moving along the northern boundary, continued to move in a generally easterly direction. At

the end of the exercise the two tanks and one TOW reached the ridgeline extending from MIKE to FOXTROT. During the movement the Team A TOW detected and destroyed a Team B TOW in the vicinity of MIKE. One of the Team A dismounted armored personnel carriers moved north of MIKE where it was destroyed by its own artillery called to cover the eastern movement. One tank, one armored personnel carrier, and one dismounted infantry squad remained of the Team A southern element at the end of the exercise. The tank was located at the road junction southwest of FOXTROT, the dismounted infantry had taken positions in the treeline just west of FOXTROT, and the armored personnel carrier remained in the vicinity of TANGO where the infantry had dismounted.

Team B. The Team B movement to contact proceeded essentially as planned. The most important aspect of the movement was the serious mistake of keeping the infantry mounted while advancing near a woodline. The infantry remained mounted for almost 1,000 meters, continuing to advance despite the loss of several vehicles to Team A fire. This led to no infantry protection for the Team B armored vehicles. Team B was only able to destroy two Team A vehicles. The first was one of the Team A TOWs, destroyed by indirect fire in the vicinity of TANGO. The second was a long range engagement by one of the Team B TOWs which detected a Team A tank on the eastern slope of TANGO. The TOW was later destroyed as it was being ground mounted at MIKE. At the end of the exercise the one remaining Team B tank and one remaining TOW were positioned in the vicinity of FOXTROT.

COMMENTS:

Team A had two and a half weeks of REALTRAIN experience prior to this exercise. In contrast, this exercise represented only the third REALTRAIN exercise for Team B. The effects of the REALTRAIN experiences are evident in the conduct differences of the two teams.

The success of Team A reflects the excellent coordination between the Team A elements as they detected, engaged, and informed other elements of the enemy actions, adjusted artillery and closely coordinated with each other in the thorough destruction of Team B. In contrast, elements of Team B generally failed to keep one another informed of critical events. For example, interviews with individual Team B members revealed that Tank 15, the first Team B

tank loss in the exercise, had detected tanks and a TOW to its front just before its destruction. The gunner detected the enemy vehicles and informed his tank commander, the tank platoon sergeant. Nevertheless, the tank platoon sergeant neglected to either inform his platoon leader about the targets or engage them. Instead, he continued to move as he was initially instructed to by his platoon leader. Of the two successful Team B engagements, one was a result of intervention on the part of its senior controller. After Team B had sustained its initial losses, its senior controller recommended to the platoon leader that artillery be called in on reported enemy positions. This action was promptly taken by the platoon leader resulting in the destruction of a Team A TOW.

APPENDIX D

DIRECT FIRE RULES OF ENGAGEMENT - ANTITANK WEAPONS

This Annex provides rules of engagement and target damage assessment by weapon type for all antitank weapons.*

NOTE: FOOTNOTES PROVIDE ADDITIONAL INFORMATION

	M72A2 LAW	M67 (90mm)	M40A2 (106)	TOW
1. Range	200 Meters	400 Meters	1100 meters	65-3000 meters
2. Preparing to Fire	a. weapon sight and plastic disc are boresighted. b. launcher extended. c. firing mechanism cocked.	a. 3X weapons sight and plastic disc boresighted. b. simulate weapon loading.	a. 3X weapons sight and 6X tele-boresighted. b. simulate weapon loading.	a. 3X weapon sight and telescope boresighted. b. guidance set operated in "ON" position c. weapon loaded.
3. Aiming	a. gunner uses M72A2's sight b. controller uses plastic disc mounted in launcher.	a. gunner uses the M67's 3X sight. b. controller uses plastic disc mounted in the rifle.	a. gunner uses M40A2 sight. b. controller uses 6X telescope mounted on weapon.	a. gunner uses 13X TOW sight. b. controller uses 10X telescope mounted on weapon.
4. Missile, Rocket	a. controller determines if flight path is unobstructed. b. if controller's cross-hairs are on target, a "hit" is awarded unless flight path was obstructed.	a. controller determines if flight path is unobstructed b. if controller's cross-hairs are on target a "hit" is awarded unless the flight path was obstructed.	a. controller determines if flight path is unobstructed. b. if controller's cross-hairs are on target a "hit" is awarded unless the flight path was obstructed.	a. controller determines time of flight to target. time of flight = Range in Meters / 200 Meters per sec. b. controller announces "hit" at end of time of flight if the flight path was unobstructed and the controller's cross-hairs were on the target at time of impact.

*Rules of Engagement for the Dragon are shown at the bottom of page 3.

APPENDIX D (Cont'd)

5. Ammunition Load	3 per squad	4 rds HE per weapon	6 rds HE per weapon	10 rds per weapon
6. Repeated firings	None. A LAW may be fired only once in each exercise.	max rate of fire one rd per six seconds not to exceed 5, followed by 15 min cooling period, one rd per min indefinitely.	max path of fire one rd per six seconds not to exceed 5, followed by 15 min cooling period, one rd per min indefinitely.	max rate of fire 2 rds per min indefinitely.
7. Weapon Signature	detonation of a grenade simulator simultaneously with firing 10 meters to the rear of the weapon.	detonation of a grenade simulator simultaneously with firing 10 meters to the rear of the weapon.	detonation of a grenade simulator simultaneously with firing 10 meters to the rear of the weapon.	detonation of a grenade simulator simultaneously with firing 10 meters to the rear of the weapon.
8. Backblast	exposed personnel in danger zone (15 meters) are killed.	exposed personnel in danger zone (30 meters) are killed.	exposed personnel in danger zone (25 meters) are killed.	exposed personnel in danger zone (50 meters) are killed.
9. *Targets*	*a. tanks, 3 LAW hits destroy a tank.* No frontal shot receives credit for a hit, only flank or rear shots. (1) 1st hit immobilizes tank, one crewman (determined by controller) becomes casualty. (2) 2d hit destroys tanks communications (radio and intercom), another crewman becomes casualty, 2d hit by any other AT weapon destroys the tank, crew is killed. b. other vehicles: (1) 1st hit destroys vehicles and 25% of on-board personnel. (2) 2d hit by any AT weapon kills remaining on-board personnel. c. bunkers, emplacements, 1st hit destroys bunker and exposed personnel within 5 meter radius.	a. tanks, 2 90mm hits are required to destroy a tank. (1) 1st hit immobilized tank, destroys tanks communication, and 50% crew. (2) 2d hit by any AT weapon destroys the tank and all on-board personnel. b. Other vehicles, a hit destroys the vehicle and all personnel are killed. c. bunkers, emplacements, 1st hit destroys bunker and exposed personnel within 5 meter radius.	a. vehicles, one hit by a 106mm destroys the vehicle and on-board personnel. b. bunkers, emplacements, 1st hit destroys bunker and exposed personnel within 10 meter radius.	a. vehicles, one hit by a TOW missile destroys the vehicle and on-board personnel. b. bunkers, emplacements. 1st hit destroys bunker and personnel within meter radius.

DRAGON

1.	Range	65-1000
2.	Preparing to Fire	a. 6X telescope and crosshairs inside field handling trainer are boresighted. (NOTE: A 3 inch diameter hole must be made in the center of aft shock absorber).
3.	Aiming	Gunner uses 6X field handling trainer telescope. Controller uses cross-hairs taped to front of tube.
4.	Missile, Rocket	a. Controller determines time of flight to target: time of flight = $\frac{\text{range in meters}}{\text{100 meters per sec}}$ b. Controller announces "hit" at end of time of flight if the flight path was unobstructed and the controller's cross-hairs were on target at time of impact.
5.	Ammunition Load	3 rds per weapon.
6.	Repeated Firings	one rd per 45 seconds, tracker must be removed after each shot and fitted to a new round.
7.	Weapons Signature	Detonation of a hand grenade simulator simultaneously with firing 10 meters to the rear of the weapon.
8.	Backblast	exposed personnel in danger zone (30 meters) are killed.
9.	Targets	a. vehicles, one hit by a DRAGON missile destroys the vehicle and on-board personnel. b. bunkers, emplacements, 1st hit destroys bunker and exposed personnel within 10 meter radius.

CASUALTY ASSESSMENT - INDIRECT FIRE

81MM MORTAR

a. 0-25 meters-any exposed personnel are casualties, vehicles lose communications.
b. 25-50 meters - fires for effect suppress a unit for 5 minutes, armored vehicles must button-up for 5 minutes.

4.2 INCH MORTAR/105MM ARTILLERY

a. 0-50 meters - any exposed personnel are casualties, vehicles lose communications.
b. 50-100 meters - fires for effect suppress a unit for 5 minutes, armored vehicles must button-up for 5 minutes.

155MM ARTILLERY

a. 0-10 meters - tanks immobilized with loss of communications.
b. 0-50 meters - all exposed personnel are casualties, all vehicles except tanks are destroyed, tanks are suppressed.
c. 50-200 meters - Fires for effect suppress a unit for 5 minutes, armored vehicles must button-up.

CASUALTY ASSESSMENT - INFANTRY WEAPONS

M16A1 ANTIPERSONNEL MINE

- All personnel within a 25 meter radius are casualties.
- Any vehicle whose tread detonates an AP mine is immobilized.

GRENADE

- Any exposed personnel within 5 meters becomes a casualty.

M21 ANTITANK MINE

-Tanks
a. tilt rod struck by bell of tank destroys vehicle.
b. tilt rod struck by track immobilized vehicle.
-All other vehicles are destroyed.

CLAYMORE MINE

-Any exposed personnel in 15 meter backblast fan or lethal fan (50 meters wide) at range of 50 meters become casualties.
-Controllers must determine effective range based on terrain and proper aiming.

M16A1 RIFLE

-Any personnel whose helmet is identified becomes a casualty.

M60 MACHINEGUN

-Asst Gunner uses 7x50 binoculars at gun level to identify helmet numbers.
-Gunner must fire burst of 6 rds for each casualty.
-When the opposing force controller determines that his element is suppressed that element:

(1) Must remain prone while gun is firing or until cover is reached.
(2) Any personnel not prone while the MG is firing become casualties.

RULES OF ENGAGEMENT - TANK WEAPONS

	MAIN GUN (M60 Series)	COAX
1. Range	4400 M	1100 M
2. Prepare to Fire	a. gunners primary direct fire sight and TC's range finder sight aligned with 10X telescope. b. TC ranges to target and gives proper fire command. c. Simulate loading weapon, gunner switches on, safety in the "FIRE" position, loader announces "UP". d. gunner indexes proper ammo into computer lays gun and announces "IDENTIFIED".	SAME
3. Aiming and Missile Flight	a. Controller uses 10X breech mounted telescope to determine if flight path is unobstructed. (N.B.: HEP and AE AT will not penetrate heavy loads, SABOT will). b. If controllers cross-hairs are on target, a hit is given; if not the controller senses the round.	a. Playing of coax engagements is the same as for main gun with the following exceptions: (1) Coax must fire (2) Controller transmits azimuth and/or location of target on the control net.
4. Weapon Signature	a. Main gun simulator	a. Coax BFA and blank ammo.
5. Targets	a. Vehicles and bunkers; one round hit by 105mm gun destroys targets and all exposed personnel within 10 meters of target become casualties.	a. Exposed personnel become casualties; engaged element is suppressed.

APPENDIX E

Table E-1

TOTAL CASUALTIES, SITE 1 (15 EXERCISES)

	Casualties Incurred by A Teams									Casualties Incurred by B Teams								
No. Played		Tanks 74		TOW 30	APC 30	Tot Veh 134	Crew 446	INF 299	Tot Pers 745		Tanks 73		TOW 30	APC 30	Tot Veh 133	Crew 441	INF 299	Tot Pers 740
Weapons	Imm	Imm Then Killed	Killed	Losses						Imm	Imm Then Killed	Killed	Losses					
Tk main gun		1	13		2	16	53	7	60		3	12	2	6	23	66	21	87
TOW		1	5	6	1	13	47		47		1	1	5	0	7	24	1	25
LAW	4			1	3	4	12	5	17	2						5	1	6
Dragon			4	1		5	20	1	21		1	3	1	4	9	23		23
90mm	6	5			2	7	25		25	4	3			1	4	17		17
Arty	11			2	5	7	21	61	82	19			2	7	9	21	54	75
X-16							13	60	73							10	43	53
X60 Mach gun								3	3								9	9
COAX MG								5	5									
Grenade					1	1	3	12	15							3	19	22
Claymore								3	3									
Mine								1	1									
Self-inflicted			1			1	4	6	10		1	2		1	4	12	8	20
Total	14		30	10	14	54	198	164	362	17		27	10	19	56	181	156	337

Table E-2

TOTAL CASUALTIES, SITE II (14 EXERCISES)

	Casualties Incurred by A Teams									Casualties Incurred by B Teams								
No. Played		Tanks 68		TOW 25	APC 28	Tot Veh 121	Crew 396	INF 301	Tot Pers 697		Tanks 66		TOW 30	APC 28	Tot Veh 124	Crew 408	INF 304	Tot Pers 707
Weapons	Imm	Imm Then Killed	Killed	Losses						Imm	Imm Then Killed	Killed	Losses					
Tk main gun		1	15		2	18	63	28	91		4	18	9	4	35	122	9	131
TOW		1	13	4	1	19	71		71		1	7	3	1	12	44	11	55
LAW	4	1		2	3	6	18		18	4	2		1		3	11		11
90mm	3	2			2	4	14	16	30	7	4			1	5	28	14	42
Arty	6			5	4	9	29	23	52	7			3	4	7	27	28	55
X-16							8	30	38							12	35	47
M60 Mach gun							4	2	6								2	2
COAX MG								2	2									
Grenade								6	6							3	6	9
Claymore								3	3									
50 Cal								3	3								2	2
Self-inflicted			1	1	2	4	8		8	1		3	2	1	6	23	1	24
Total	8		34	12	14	60	215	113	328	8		39	18	11	68	270	108	378

Table E-3

TOTAL CASUALTIES, SITE III (13 EXERCISES)

	Casualties Incurred by A Teams									Casualties Incurred by B Teams								
No. Played		Tanks 65		TOW 26	APC 26	Tot Veh 117	Crew 390	INF 317	Tot Pers 707		Tanks 65		TOW 26	APC 26	Tot Veh 117	Crew 390	INF 319	Tot Pers 707
Weapons	Imm	Imm Then Killed	Killed	Losses						Imm	Imm Then Killed	Killed	Losses					
Tk Main gun		1	11	2		14	51	23	74			14	3	7	24	71	35	106
TOW			6	2	1	9	33		33			12	3		15	60		60
LAW	1	1				1	3		3	1	1		2		3	10		10
90mm	8	4			1	5	27	1	28	3				2	2	8	3	11
Arty	8				4	4	12	21	33				2	4	6	18	43	61
M-16							7	32	39							4	42	46
M60 Mach gun							1	7	8							6	6	12
Grenade				1		1	4	5	9			1		1	2	5	6	11
Self-inflicted			3	1		4	15	4	19			1			1	3		3
Total	11		26	6	6	38	153	93	246	3		29	10	14	53	185	135	320

Table E-4

TOTAL CASUALTIES, SITE IV (17 EXERCISES)

	Casualties Incurred by A Teams									Casualties Incurred by B Teams								
No. Played		Tanks 80		TOW 34	APC 34	Tot Veh 148	Crew 490	INF 366	Tot Pers 856		Tanks 80		TOW 34	APC 39	Tot Veh 148	Crew 490	INF 366	Tot Pers 856
Weapon	Imm	Imm Then Killed	Killed	Losses						Imm	Imm Then Killed	Killed	Losses					
Tk Main gun			6	2	5	13	37	41	78		5	14		3	22	74	18	92
TOW			6	4	1	11	41		41			2	1		3	12		12
LAW	4	4			2	6	15	1	16	5	3		1	4	8	20	2	22
90mm	8	3		2	2	7	31	6	37	22	13		3	3	19	87	13	100
Arty	6			8	4	12	51	61	112	13			7	8	15	67	81	148
M-16							1	52	53							3	81	84
M60 Mach gun								5	5								4	4
COAX MG								2	2								1	1
Grenade			2		1	3	9	8	17			2			2	8	4	12
Mine								1	1									
Self-inflicted	2	2				2	4	6	10	1	2	2		1	5	15	15	30
Total	11		23	16	15	54	189	183	372	18		43	12	19	74	286	219	505

Table E-5

TOTAL CASUALTIES, FIRST WEEKS (17 EXERCISES)

	Casualties Incurred by A Teams									Casualties Incurred by B Teams								
No. Played		Tanks 83		TOW 34	APC 34	Tot Veh 150	Crew 502	INF 364	Tot Pers 866		Tanks 82		TOW 34	APC 34	Tot Veh 150	Crew 498	INF 367	Tot Pers 865
Weapon	Imm	Imm Then Killed	Killed	Losses						Imm	Imm Then Killed	Killed	Losses					
Tk Main gun		2	13	1	2	18	57	13	70		4	18	4	10	36	106	54	160
TOW		1	12	5	2	20	72		72			7	7		14	53		53
LAW	4	3		1	5	9	19	4	23	1						2		2
Dragon			1				4		4					2	2	9		9
90mm	13	6		1	5	12	47	5	52	9	4				4	28	3	31
Arty	11			3	4	7	29	26	55	16			2	5	7	28	36	64
M-16							16	45	61							5	47	52
M60 Mach gun							1	1	2							2	2	4
COAX MC								5	5									
Grenade			1	1		2	8	8	16							1	12	13
Claymore								3	3									
50 Cal								3	3								2	2
Self-inflicted	1		2	1		3	13	8	21	1	1	4			5	20	7	27
Total	17		41	13	18	72	266	121	387	18		38	13	17	68	254	163	417

Table E-6

TOTAL CASUALTIES, SECOND WEEKS (18 EXERCISES)

	Casualties Incurred by A Teams									Casualties Incurred by B Teams								
		Tanks		TOW	APC	Tot Veh	Crew	INF	Tot Pers		Tanks		TOW	APC	Tot Veh	Crew	INF	Tot Pers
No. Played		92		33	36	161	536	401	937		88		38	36	162	540	394	934
Weapon	Imm	Imm Then Killed	Killed	Losses						Imm	Imm Then Killed	Killed	Losses					
Tk Main gun		1	11		2	14	49	33	82		3	14	7	5	29	91	11	102
TOW			10	4	2	16	58		58		1	4	3		8	31	1	32
LAW	5	1		1	1	3	13	1	14	4	2		3		5	20		21
Dragon				1		1	4		4			2	1	2	5	14		14
90mm	7	3			2	5	24	17	41	14	7		2	3	12	55	10	65
Arty	8			4	6	10	41	71	112	10			3	9	12	44	59	103
M-16							9	70	79							15	50	65
M60 Mach gun							3	3	6								3	3
COAX MG								3	3									
Grenade			1		2	3	8	11	19			3		1	4	17	12	29
Claymore Mine								1	1									
Self-inflicted			2	1	1	4	13	2	15	1		4		1	5	19	6	25
Total	15		29	11	16	56	222	212	434	16		40	19	21	80	306	153	459

Table E-7

TOTAL CASUALTIES, THIRD AND FOURTH WEEKS (24 EXERCISES)

	Casualties Incurred by A Teams									Casualties Incurred by B Teams								
No. Played		Tanks 111		TOW 48	APC 48	Tot Veh 207	Crew 684	INF 518	Tot Pers 1202		Tanks 113		TOW 48	APC 48	Tot Veh 209	Crew 691	INF 527	Tot Pers 1218
Weapon	Imm	Imm Then Killed	Killed	Losses						Imm	Imm Then Killed	Killed	Losses					
Tk Main gun			21	3	5	29	98	53	151		5	26	3	5	39	136	18	154
TOW		1	8	7		16	62		62		1	11	2	1	15	56	11	67
LAW	4	2		1	2	5	16	1	17	7	4		1	4	9	24	2	26
Dragon			3			3	12	1	13									
90mm	5	5		1		6	26	1	27	13	9		1	4	14	57	17	74
Arty	12			8	7	15	43	69	112	13			9	9	18	61	111	172
M-16							4	59	63							9	104	113
M60 Mach gun							1	13	14							4	16	20
COAX MG								1	1								1	1
Grenade								12	12							1	11	12
Claymore								3	3									
Mine								1	1									
Self-inflicted	1	2	1		1	4	5	6	11		2	0	2	2	6	14	11	25
Total	12		43	20	15	78	267	220	487	12		58	18	25	101	362	302	664

Table E-8

PERCENT CASUALTIES FOR VARIOUS TARGET TYPES INFLICTED BY TEAM A AND TEAM B AS A FUNCTION OF WEAPON USED (IN PERCENT OF TOTAL CASUALTIES)

Weapon	By	Tanks (Imm.)	Tanks (Destr.)	TOW	APC	Total Vehicles Destr.	Personnel
Tank	A		28%	15%	18%	23%	15%
Main Gun	B		19	4	8	13	11
TOW	A		10	13	1	8	5
	B		13	17	4	12	7
90 mm	A	23%	8*	3	6	7	6
	B	15	6	2	6	5	4
LAW	A	8	2*	4	4	3	2
	B	8	2	3	7	4	2
Artillery	A	25		15	21	8	12
	B	20		16	16	7	10
M16	A						8
	B						7
Coax and M60	A						1
	B						1
Grenade	A		1		1	1	2
	B		1	1	2	1	2
Other	A	1	5	3	6	5	4
	B	2	4	3	2	4	3
Total	A	56	55	53	56	55	55
	B	44	45	47	44	45	45
Number		158	249	94	112	455	2848

*Second hit.

APPENDIX F

Communications Analysis

For each exercise, the following information was isolated. From Form A, the time at which each casualty was inflicted, the total number of personnel involved in the exercise, the time the exercise began and ended, and the times at which tanks, TOWs, or armored personnel carriers (APCs) were immobilized or destroyed. From Form D*, the judgment of the Mobile Training Team (MTT) concerning who had "won" the exercise was noted. From Form G, the number of communications in every ten minute interval after the exercise began was obtained. The number of radio transmissions per ten minute interval was adjusted for the number of remaining personnel in that interval. Twenty radio transmissions for a ten minute interval for 35 individuals 40 minutes after the exercise had begun was assumed, for example, to be a higher communication rate than 20 radio transmissions for a ten minute interval for 50 individuals at the outset of the exercise. In REALTRAIN/USAREUR training, radios as well as weapons were not considered destroyed unless a direct hit was sustained by an appropriately lethal weapon. Thus, radios could be used by any remaining personnel, and it was thought necessary to adjust the communication rate for the number of potential communications left in that time interval. Consequently, the Communication Index (C.I.) was defined as:

$$\frac{100 \sum_{i=1}^{N} \frac{C_i}{P_i}}{N}$$

where C_i = the number of radio transmissions in any ten minute interval, "i".

P_i = the remaining personnel in any ten minute interval, "i"

N = the number of ten minute intervals in the exercise.

(A radio transmission was defined as any entry into the Communications Record in which a communication number was recorded, presumably signifying individual number "XX" had either attempted or made a radio transmission.) In the first analysis, a percent difference score between the communication

---

*Form D was used to sample opinion of the MTT as to team performance.

indices for Teams A and B was calculated. This percent difference (p.d.) score is defined as:

$$\frac{C.I._A - C.I._B}{C.I._A + C.I._B}$$

and used as a summary statistic for describing the difference in communication rates for A and B without using the C.I. of either team as the baseline score.

In tabular form, the C.I. for Teams A and B, the percent difference score, and judged exercise outcome was compared to the casualty rate (C.R.) for Teams A and B. The casualty rate is defined as the number of casualties inflicted divided by the minutes the exercise ran. A difference score for casualty rates of A and B was computed using the same formula as for the percent difference scores for the Communication indices (i.e., $C.R._A - C.R._B$).

$$\frac{C.R._A - C.R._B}{C.R._A + C.R._B}$$

Form F

PARTICIPANT QUESTIONNAIRE

Name (and Rank)_____ Unit_____

Date_____

MOS_____ Duty Position_____

1. (Infantry personnel) Had you received any SCOPES training prior to these exercises?

Yes_____ No_____

2. (Armor personnel)

a. When did your crew last fire Table VIII?

_____months ago _____never fired

b. Did your crew qualify?

Yes _____ No_____

3. Compared to the normal unit training your unit conducts, do you feel that REALTRAIN is

_____a. Much less effective
_____b. Somewhat less effective
_____c. Equally effective
_____d. Somewhat more effective
_____e. Much more effective

4. How would you rate your unit's state of training for combat before the REALTRAIN exercises?

_____a. Highly trained
_____b. Adequately trained
_____c. Minimally trained
_____d. Poorly trained
_____e. Untrained

5. How would you rate your unit's state of training after the REALTRAIN exercises?

_____a. Highly trained
_____b. Adequately trained
_____c. Minimally trained
_____d. Poorly trained
_____e. Untrained

Form F

6. Do you think these exercises demanded the same kinds of tactics you would expect to use in actual combat?

_____a. Yes
_____b. Some differences
_____c. Many differences
_____d. No

7. How much do you feel you learned from the After Action Review that you did not learn in the exercises?

_____a. A great deal
_____b. Some additional information
_____c. Very little
_____d. Nothing

8. Check all of those statements listed below that describe your opinions of the After Action Reviews:

_____a. There was usually something to learn from an After Action Review (AAR)
_____b. When I had been a casualty, I felt uncomfortable discussing it before the group.
_____c. Generally, I felt that my contribution to the AAR was welcomed.
_____d. I can't honestly say I learned anything new from an AAR.
_____e. I could get a much better understanding of where my unit fit into the overall action during the AAR.
_____f. AARs were boring most of the time.

9. Do you have any suggestions for improving the After Action Review?

Suggestions:

Form R

LEADER/CONTROLLER QUESTIONNAIRE

DATE: _____

NAME: _____

RANK: _____

UNIT: _____

CURRENT DUTY POSITION: _____

LEADERSHIP EXPERIENCE:

DUTY POSITION	RANK	INCLUSIVE DATES
_____	_____	_____
_____	_____	_____
_____	_____	_____
_____	_____	_____

1. Compared to live fire exercises, REALTRAIN is:

   a. Far more effective _____

   b. More effective _____

   c. A little more effective _____

   d. About the same _____

   e. A little less effective _____

   f. Less effective _____

   g. Far less effective _____

2. Compared to traditional field exercises which do not employ engagement simulation devices, REALTRAIN is:

   a. Far more effective _____

   b. More effective _____

   c. A little more effective _____

d. About the same _____

e. A little less effective _____

f. Less effective _____

g. Far less effective _____

3. Compared to by-the-number battle drill exercises, REALTRAIN is:

a. Far more effective _____

b. More effective _____

c. A little more effective _____

d. About the same _____

e. A little less effective _____

f. Less effective _____

g. Far less effective _____

4. In spite of the success TRADOC has had with REALTRAIN, it does not feel that a single training method will accomplish everything required to fully prepare a unit to go into combat.

a. If you had sufficient time and resources to conduct an adequate tactical training program, what percentage of your field training would you devote to the following training methods:

(1) By-the-number battle drill exercises _____% of time

(2) Traditional field exercises which do not employ engagement simulation devices _____% of time

(3) Live fire exercises _____% of time

(4) REALTRAIN exercises _____% of time

b. If you only had time and resources to conduct an extremely constrained tactical training program, what percentage of your field training would you devote to the following training methods:

(1) By-the-number battle drill exercises _____% of time

(2) Traditional two sided field exercises which do not employ engagement simulation devices _____% of time

(3) Live fire exercises _____% of time

(4) REALTRAIN exercises _____% of time

5. How effective do you consider REALTRAIN to be for training units to:

	Very Effective	Effective	Not Effective
a. Use terrain for cover and concealment	_____	_____	_____
b. Employ indirect fire	_____	_____	_____
c. Properly employ all available weapons	_____	_____	_____

6. During the past six months:

a. How many days has an average platoon in your unit spent in the field on tactical training each month? _____

b. How many men have been in an average platoon when it has gone to the field for tactical training? _____

c. How many of these men were NCO's?_____

d. How many days has your unit spent at a major training area?_____

7. Rate the following items from 1 to 5 according to the impact each has on the tactical training program in your unit (1 indicates that an item has great impact and 5 indicates that it has little impact.)

a. Lack of adequate training areas _____

b. Lack of qualified NCOs _____

c. Nonavailability of personnel for training due to on duty education, post support,etc. _____

d. Lack of POL or training ammunition _____

e. Major items of equipment down for maintenance _____

f. Personnel turbulence due to rotation or reassignment _____

8. List the most important individual and team skills that you think REALTRAIN exercises impart.

INDIVIDUAL	TEAM

9. Do you have any suggestions concerning how REALTRAIN could be improved?

_____

_____

_____

_____

_____

10. (Infantry Only). The following questions concern Squad Combat Operations Exercise (Simulation) or SCOPES and the related equipment and exercises.

a. Does your unit have SCOPES equipment? ____ Yes ____ No

b. How many days has your unit spent on SCOPES exercises during the past 6 months? _____ days

c. How many days do you feel your unit should spend on SCOPES exercises during a 6 months period to be prepared for combat? _____ days

11. (Controllers only) What do you feel is the training value of REALTRAIN exercises for a controller?

a. _____Much greater than for a participant

b. _____ Somewhat greater than for a participant

c. _____ About the same as for a participant

d. _____ Somewhat less than for a participant

e. _____ Much less than for a participant

Please explain your answer:_____

_____

_____

_____

_____

12. (Controllers Only) What types of individual and team skills do you feel controllers develop during REALTRAIN exercises?

INDIVIDUAL	TEAM

13. (Controllers only) How well do you feel that this week of instruction has prepared you to implement REALTRAIN in your unit?

a._____completely prepared

b. ____well prepared

c. ____adequately prepared

d. ____not very well prepared

e. ____poorly prepared

14. (Controllers only) What changes (additions, deletions, expansion, etc.) would you recommend to improve the training you received this week?

_____

_____

_____

_____

_____

75:5104c

APPENDIX G

Table G-1

PARTICIPANT QUESTIONNAIRE RESPONSES BY TEAM AND SITE

Item	Response	A Teams Site I	II	III	IV	TOT.	B Teams Site I	II	III	IV	TOT.	A+B TOT.
3*	a&b	1	1	4		6	3	9	7	3	22	28
	c	1	1	2	1	5	12	12	14	13	51	56
	d	8	8	5	8	29	18	29	13	27	87	116
	e	25	27	18	27	97	70	57	59	61	247	344
4	a	4		3	2	9	9	9	11	1	30	39
	b	9	15	9	10	43	37	51	25	41	154	197
	c	13	13	10	11	47	38	23	40	42	143	190
	d&e	9	8	7	13	37	17	25	15	19	76	113
5	a	11	22	9	17	59	38	31	27	30	126	185
	b	18	14	13	16	61	56	47	44	52	199	259
	c	4	1	4	1	10	5	22	16	15	58	68
	d&e	2	1	3	2	8	2	8	5	6	21	29
6	a	20	24	14	26	84	53	60	56	55	224	308
	b	13	12	10	8	43	34	39	28	32	133	176
	c&d	1	1	4		6	6	9	7	10	32	38
7	a	20	13	6	18	57	49	48	44	46	187	244
	b	15	22	16	14	67	40	47	39	37	163	230
	c&d		2	6	2	10	5	13	8	13	39	49
8	a	26	33	19	31	109	75	75	75	72	297	406
	b	4	1	2	10	17	15	7	11	11	44	61
	c	13	24	15	16	68	36	43	33	37	168	236
	d	1	2	4	6	13	8	17	10	13	48	61
	e	24	24	12	20	80	56	56	43	47	207	282
	f	5	2	3	1	12	4	8	8	7	27	39

*For Items 1 and 2 see Tables 2 and 3.

Table G-2

INFANTRY PARTICIPANT QUESTIONNAIRE RESPONSES BY TEAM AND SITE

Item	Response	A Teams Site I	II	III	IV	Tot.	B Teams Site I	II	III	IV	Tot.	A+B Tot.
1	Yes	14	13	3	3	33	24	51	21	31	127	
	No	10	8	11	19	48	28	16	27	17	88	
3	a&b	1	1	2		4		8	3	1	12	16
	c	1		1	1	3	8	7	10	5	30	33
	d	3	5	3	7	18	10	19	9	9	47	65
	e	19	15	8	14	56	38	34	26	34	132	188
4	a	3		1	2	6	4	6	10	1	21	27
	b	7	12	6	8	33	20	37	12	17	86	119
	c	9	7	4	6	26	22	15	20	23	80	106
	d&e	5	2	3	6	16	9	10	5	7	31	47
5	a	6	11	6	10	33	18	24	14	13	69	102
	b	13	9	3	10	35	32	28	22	25	107	141
	c	4		3		7	4	13	9	7	33	40
	d&e	1	1	2	2	6	2	3	3	4	12	18
6	a	13	12	8	13	46	27	34	24	25	110	156
	b	10	8	1	7	26	24	26	19	12	81	107
	c&d	1	1	4		6	2	8	4	8	22	28
7	a	14	7	2	9	32	24	28	20	22	94	126
	b	10	14	7	10	41	25	32	22	16	95	136
	c&d			4	1	5	4	8	5	7	24	29
8	a	16	19	7	20	62	39	41	38	28	146	208
	b	2	1	2	4	9	9	4	10	5	38	47
	c	11	13	6	8	38	21	24	20	19	103	141
	d	1		4	4	9	7	10	5	6	28	37
	e	18	12	8	10	48	30	33	27	22	112	160
	f	3	1	3	1	8	3	6	4	5	18	26

Table G-3

ARMOR PARTICIPANT QUESTIONNAIRE RESPONSES BY TEAM AND SITE

Item	Response	A Teams Site I	II	III	IV	Tot.	B Teams Site I	II	III	IV	Tot.	Tot.
2a	0-4	11	10	1	6	28	27	26	0	10	63	91
	5-12		3	4	4	11	4	1	10	20	35	46
	13+		1	4		5			8	1	9	14
	Never			6		6	9	10	23	21	63	69
b	Yes	11	11	7	9	38	24	18	14	26	82	120
	No		3	2	2	7	9	7	6	5	27	34
3	a&b			2		2	3	1	4	2	10	12
	c		1	1		2	4	5	4	8	21	23
	d	5	3	2	1	11	8	10	4	18	40	51
	e	6	12	10	13	41	32	23	33	27	115	156
4	a	1		2		3	5	3	1		9	12
	b	2	3	3		10	17	14	13	24	68	78
	c	4	6	6	5	21	16	8	20	19	63	84
	d&e	4	6	4	7	21	8	15	10	12	45	66
5	a	5	11	3	7	26	20	7	13	17	57	83
	b	5	5	10	6	26	24	19	22	27	92	118
	c		1	1	1	3	1	9	7	8	25	28
	d&e	1		1		2		5	2	2	9	11
6	a	7	12	6	13	38	26	26	32	30	114	152
	b	3	4	9	1	17	10	13	9	20	52	69
	c&d						4	1	3	2	10	10
7	a	6	6	4	9	25	25	20	24	24	93	118
	b	5	8	9	4	26	15	15	17	21	68	94
	c&d		2	2	1	5	1	5	3	6	15	20
8	a	10	14	12	11	47	36	34	37	44	151	198
	b	2			6	8	6	3	1	6	16	24
	c	2	11	9	8	30	15	19	13	18	65	95
	d		2		2	4	1	7	5	7	20	24
	e	6	12	4	10	32	26	23	16	25	90	122
	f	2	1		1	4	1	2	4	2	9	13