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TETAM MODEL VERIFICATION STUDY

Volume III

DYNAMIC BATTLE COMPARISONS

Technical Report TR 6-76

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TETAM MODEL VERIFICATION STUDY

Volume III

Dynamic Battle Comparisons

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ABSTRACT

The TETAM Model Verification study is reported in three volumes describing the validation of three high resolution combat simulation models (DYNTACS, IUA, and CARMONETTE) using field data collected by US Army Combat Developments Experimentation Command during Experiment 11.8. Volumes I and II contain an intervisibility study describing the abilities of the DYNTACS, IUA, and CARMONETTE terrain processors to predict line-of-sight occurrences between tanks and antitank missile positions. Volume III contains a validation study of the engagement processors of DYNTACS and IUA. The results from the simulation models in terms of firings, engagements, and losses between tank and antitank as compared with the field data collected during the free play battles of Field Experiment 11.8 are found in Volume III.

TABLE OF CONTENTS

Technical Report 6-76

TABLE OF CONTENTS (Continued)

TABLE OF CONTENTS (Concluded)

LIST OF TABLES

LIST OF TABLES (Concluded)

LIST OF FIGURES

EXECUTIVE SUMMARY

1. INTRODUCTION. The Tactical Effectiveness Testing of Antitank Missiles (TETAM) program, originated in December 1970 by Department of Defense Program Budget Decision 464, consists of three major elements: a field experiment conducted by Combat Developments Experimentation Command in 1972-73, a detailed evaluation of the effectiveness of US antitank missile weapons based primarily upon data collected during that field experiment, and an evaluation of the predictive abilities of three of the Army's high resolution simulation models of tank-antitank warfare using the results of the field experiment as a baseline. Progress on this third major element of the TETAM program, the Model Verification Study, is the subject of this report.

2. PURPOSE. The purpose of the Model Verification Study is to determine the ability of the DYNTACS, CARMONETTE, and Individual Unit Action (IUA) high resolution combat simulations to:

(1) Predict the outcomes of selected tank-antitank battles conducted during the CDEC Experiment 11.8;

(2) Represent the major battlefield activities leading to these outcomes.

3. SEQUENTIAL STUDY. Each of the three models is designed to simulate tank-antitank battles by playing the fundamental activities of participating personnel and weapon systems within the battlefield environment. These fundamental activities include the search for, detection, recognition, and identification of targets on the battlefield; the loading, laying, and firing of antitank weapons; and the process of guiding antitank missiles onto their intended targets. Volumes I and II of this study report the early inconsistencies between model and field results found in the TETAM effort and the steps taken in DYNTACS and IUA to achieve a representation of intervisibility between potential targets and firers sufficient to support investigation of other model aspects.

4. OBJECTIVES. Specific objectives of the TETAM Model Verification Study were:

a. Determine the ability of each model to portray the outcome of Experiment 11.8 tank-antitank battles.

b. Determine the degree of correlation between Experiment 11.8 and each model in portraying the following aspects of tank-antitank battles:

(1) Attacker-defender intervisibility.

(2) Movement of attacking forces.

(3) Target acquisition.

(4) Target handoff.

(5) Target assignment.

(6) Target engagement/kill.

(7) Combat intelligence.

(8) Communications.

c. Identify the major underlying assumptions relevant to tank-antitank battles for each model.

d. Identify and, where possible, prioritize needed modifications and improvements for each model.

5. CONCEPT. A threefold approach to model verification was followed:

a. Detailed comparisons of model results and field experiment outcomes were made for two trials of the field experiment. The original concept for model verification was based on the assumption that several field trials could be viewed as replications of the same battle. Review of the experiment, however, failed to identify sets of trials that could be considered replications.

b. A survey of the field trial results identified certain behavioral or operational tendencies reproduced in most field trials. These tendencies were compared to the basic model assumptions to shed further light on model validity.

c. Certain model aspects were known to the study team to be suspect. These aspects were subjected to judgmental evaluation.

6. DETAILED MODEL COMPARISONS. Detailed model comparisons were carried out for two of the Experiment 11.8 trials. The trials selected for comparison provided different situations but were typified by good maneuver control of attacking elements.

a. Trial 34 was a rapid advance trial on a medium front in which the attacking tanks stressed maintenance of movement and did not fire. Covering fire was provided by overwatching attacker ATGMs at a limited level. This trial was close to being a one-sided battle, with attacking tanks presenting a passive mobile target array.

b. Trial 96 was a fire and movement attack that was well executed by the attacking weapons that did not become disoriented upon initial contact with defender fire. Attackers in this trial maintained a cohesive attack, providing a good sample of a dynamic two-sided battle.

c. For each trial, the models were set up and run to reproduce the movement patterns of the field trials. Movement for both models was constrained to the field patterns in a much more restrictive sense than would be appropriate in typical model applications. Consequently, the ability to compare model and field movements was intentionally sacrificed to allow a controlled comparison of the detection, intervisibility, and firing processes. The model hit and kill routines were not tested in the comparison. The algorithms used in the field experiment to determine hits and kills were also used in the models.

d. Comparisons of the model and field results were made for each trial on two levels. First, the gross battle outcomes in terms of force kills were compared; then, an extensive comparison of individual weapon activity in terms of shots fired, engagements, and kills was also conducted between field and model results. The comparisons were based on 10 model replications.

e. In addition to the 10 base case replications, model excursion sets were produced to investigate the impact of specific model or data changes on results. Definition of the excursions was based on differences between the base case runs and field results.

7. ADDITIONAL MODEL CONSIDERATIONS. In addition to the detailed comparisons, various model shortcomings are discussed in this report. Identification of these shortcomings was based not only on CACDA analyst familiarity with the models and knowledge of general tendencies observed in the field that were contradicted by the models but also on apparent model inconsistencies.

8. FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS.

a. DYNTACS. The DYNTACS model produced a credible portrayal of the Experiment 11.8 battles both in terms of overall battle outcome and in the general progression of battles. Major weaknesses, however, were detected in the intelligence module and in the event sequencing logic of DYNTACS. Weaknesses of a secondary nature were noted in the movement and fire control modules. Improvements to overcome these weaknesses were identified and prioritized.

b. IUA. The IUA model produced battle outcomes consistent with Experiment 11.8 but depicted dynamic battle development different from that seen in the field. It was concluded that IUA would be appropriate for gross firepower comparisons but would be unsatisfactory for more detailed investigations, primarily due to a sterile treatment of tactics and numerous improper assumptions, most of which are unavoidable with the current model structure. Additionally, numerous logical errors or shortcuts were found throughout the model and particularly in the detection module. It was determined that the most serious shortcomings of IUA could only be overcome with total redesign. Certain modifications are recommended, but these are of a limited nature and would not relieve the limitation of IUA's applicability to that of a gross firepower comparison tool.

CHAPTER 1

INTRODUCTION

1-1. BACKGROUND. The Tactical Effectiveness Testing of Antitank Missiles (TETAM) program was originated in December 1970 by Department of Defense Program Budget Decision 464. As originally defined, the program contained two major elements. Field Experiment 11.8 was conducted by the Combat Developments Experimentation Command (CDEC) in 1972-73 (reference 1). A detailed evaluation of the effectiveness of US antitank missile weapons based primarily upon data collected during Experiment 11.8 was conducted by the US Army Combined Arms Combat Developments Activity (CACDA) in 1973-74 (reference 2). In 1972, Department of the Army added a third major element to the TETAM program, that of evaluating the predictive ability of three of the Army's frequently used high resolution simulation models of tank-antitank warfare, using the results of Experiment 11.8 as a basis for evaluation. The resulting Model Verification Study was conducted by CACDA over the period October 1973 to October 1975.

1-2. OVERVIEW OF THE MODEL VERIFICATION STUDY.

a. Purpose and Objectives. The purpose of the Model Verification Study is to determine the ability of the DYNTACS, CARMONETTE, and Individual Unit Action (IUA) high resolution combat simulations to portray the outcomes of selected tank-antitank battles as carried out during CDEC Experiment 11.8 and to represent the major battlefield activities and processes leading to these outcomes. The specific objectives are:

(1) Determine the ability of each model to portray the outcome of Experiment 11.8 tank-antitank battles.

(2) Determine the degree of correlation between Experiment 11.8 and each model in portraying the following aspects of tank-antitank battles:

(a) Attacker-defender intervisibility.

(b) Movement of attacking forces.

(c) Target acquisition.

(d) Target handoff.

(e) Target assignment.

(f) Target engagement/kill.

(g) Combat intelligence.

(h) Communications.

(i) Supporting fires.

NOTE: The list of battle aspects to be considered varied during the course of the study. All items shown were identified as candidates for comparisons at one time or another during the study.

(3) Identify the major underlying assumptions relevant to tank-antitank battles for each model.

(4) Identify and, where possible, prioritize needed modifications and improvements for each model.

b. Historical Narrative.

(1) Preliminary stages.

(a) Planning. Responsibility for accomplishing the Model Verification Study was initially assigned to the Systems Analysis Group (SAG) of the US Army Combat Developments Command. SAG had formulated a general approach to the model verification work by March 1973. At that time, as part of the 1973 reorganization of the US Army, responsibility for the study was transferred to CACDA. CACDA expanded this general approach into a specific concept for model verification, which was presented to the TETAM Senior Officer In-Process Review on 20 June 1973 (reference 3). This plan called for a sequential approach to model verification to begin with verification of each model's representation of intervisibility, followed by analysis of each model's play of detection and, finally, by an investigation of the weapon interactions in dynamic, force-on-force engagements. This approach followed the same general sequence established within the three major phases of CDEC Experiment 11.8. As illustrated in figure 1-1, each step was to involve a comparison of model and field results, determination of sources of observed differences, and corrective actions necessary to continue the process.

(b) Preparation. Of the three models to be evaluated, one (IUA) was the responsibility of CACDA from the outset of the study. Responsibility for a second model (DYNTACS) was transferred from SAG to CACDA in July 1973. This transfer did not include the transfer of personnel familiar with the model, and a program of formal training on the setup and operation of DYNTACS was conducted for CACDA programers and analysts in November and December 1973 (reference 4). US Army Concepts Analysis Agency (CAA) agreed to operate the third model (CARMONETTE)

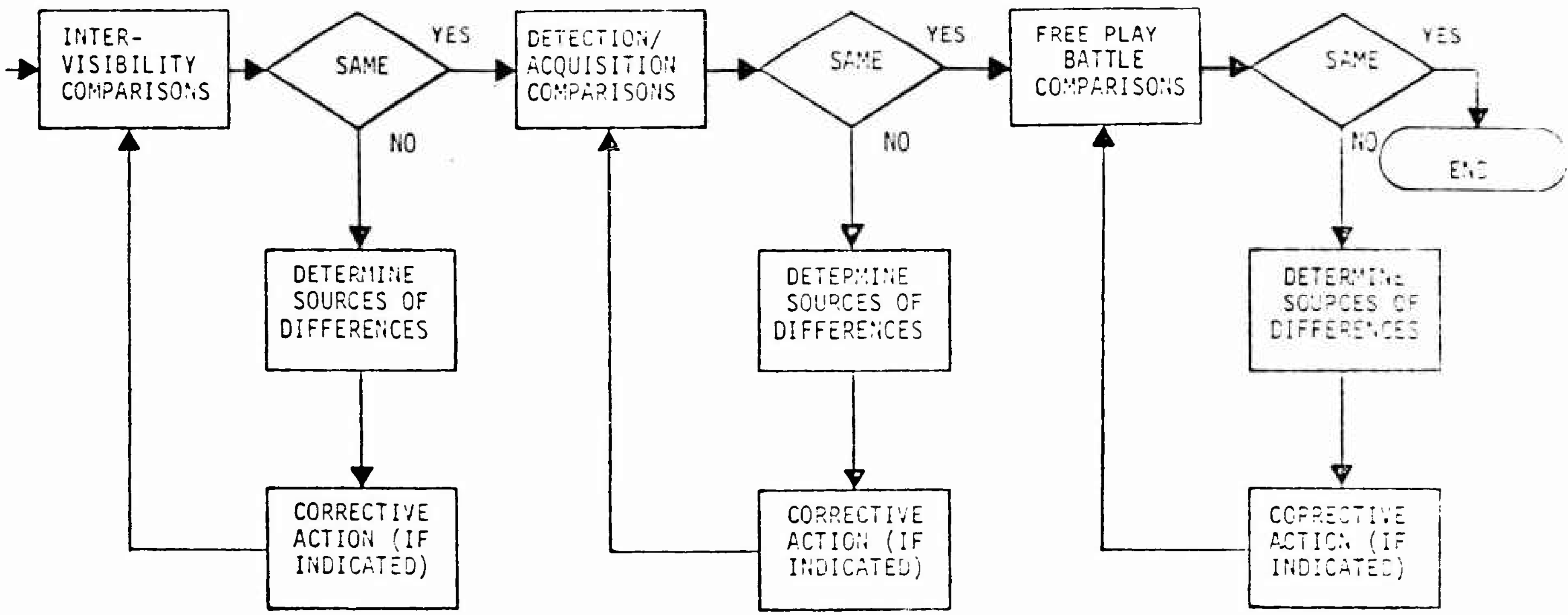


Figure 1-1. Sequential Nature of Model Verification

in support of the model verification work. By mid-January 1974, all three models were being operated in support of the model verification objectives. Detailed intervisibility data collected in the execution of Experiment 11.8 were obtained from CDEC during the last quarter of 1973 and were in a form suitable for the comparisons in January 1974.

(2) Original intervisibility comparisons. The original comparisons of intervisibility data produced by the three models with the Experiment 11.8 intervisibility data were conducted during the period January through May 1974, with an interim report being published in June 1974. The original comparisons were conducted to determine whether the models portrayed intervisibility levels and patterns consistent with those observed in Experiment 11.8. It was anticipated that the level of disagreement between model and field results would be relatively minor and that work could progress into investigations of model representation of detection and battle free play with minimal model adjustments. Contrary to expectations, model results were found to be in serious disagreement with the intervisibility data collected during Experiment 11.8. The original comparisons are contained in volume I of this study report (reference 5).

(3) Approach revision. The extreme disagreement between model and Experiment 11.8 realizations of intervisibility dictated that further project resources be expended to clarify the causes of this disagreement and to attempt to improve model representation of intervisibility. The study approach was revised to permit continued intervisibility work and, concurrently, to begin the necessary model preparation and field experiment review for the free play comparisons. The study phase dealing with detection as an isolated process was estimated to require a resource increment approximately equal to that already expended on the intervisibility comparisons and was not amenable to initiation until the intervisibility situation had been resolved. Lacking such resources, the detection study phase was dropped from the approach. The revised approach was approved by the Model Verification Study Project Review Board on 15 October 1974. In the interim, the CAA commitment to operate CARMONETTE in support of the study had expired, and the follow-on work was limited to the DYNTACS and IUA models.

(4) Follow-on intervisibility comparisons. The second series of intervisibility comparisons was conducted over the period October 1974 to July 1975, with some preliminary excursions being attempted in August and September 1974. This effort included a critical review of the field experiment as well as significant revisions to the DYNTACS and IUA representations of intervisibility. Additionally, a terrain representation model, which involved a significantly higher level of resolution than that found in the combat simulations, was investigated. This fourth model

is a product of the Corps of Engineers Waterways Experiment Station (WES) and was operated by WES in support of the study. The follow-on intervisibility work resulted in representations of intervisibility within DYNTACS and IUA that were in sufficient agreement with the Experiment 11.8 data to allow the study to progress into the dynamic battle comparisons. This work is reported in volume II of this study report (reference 6).

(5) Dynamic battle comparisons. The comparisons of dynamic force-on-force battles as represented in IUA and DYNTACS and as carried out in Experiment 11.8 were conducted during the period November 1974 to September 1975. A significant portion of this effort involved an extensive review of the experimental procedures and data. This review was required to develop a detailed appreciation of what took place in the free play trials of Experiment 11.8. This review and a comparison of model and field results for selected battles, as well as a critical review of model aspects for which no comparison data from Experiment 11.8 were available, constitute the dynamic battle, or free play, portion of the Model Verification Study and are reported in this volume of the study report.

1-3. PURPOSE AND SCOPE OF REPORT. In this volume, comparisons are made between the results attained with DYNTACS and IUA and the results of selected trials of CDEC Experiment 11.8, Phase III. Additionally, a brief critical review of selected model aspects is presented, and needed model improvements are identified. This investigation of model performance was limited to interactions between opposing tanks and ground antitank weapons used in Experiment 11.8; model representation of other systems, such as indirect fire weapons or aerial platforms, was not considered.

1-4. OVERVIEW AND REPORT ORGANIZATION.

a. Requirement. Detailed combat simulations, such as DYNTACS and IUA, became possible with the introduction of modern electronic computers; and the first operational models of this type appeared in the late 1950s. Although the Army has used models of this type since their inception, primarily in a weapons system evaluation context, the credibility and validity of such models has remained an open issue. Attempts at model validation have been limited to comparisons among models, primarily because a combat experience basis of comparison, with sufficient detailed information to insure that the models portray the actual conditions, has not been available. CDEC Experiment 11.8 provided a potential for improving that situation, a large amount of detailed information was collected under conditions having an aura of dynamic combat made possible by the assessment of losses in near real time. Thus, the TETAM Model Verification Study addresses the long-standing issue of model validity using a basis of comparison that is potentially more useful than those previously available.

b. Approach. The approach taken to model verification followed three lines of inquiry: detailed comparison of model and experimental results for selected field experiment trials, review of model performance in light of certain operational tendencies generally observed in the field experiment, and a critical review of selected model features for which no comparison with field results was practical. These approaches are presented in chapter 2. Most of the study effort was expended in the first approach, detailed comparisons of selected trials, and this work required a detailed review of the individual field experiment trials, which is contained in appendix D.

c. Detailed Trial Comparisons. Detailed comparisons of model and field results are contained in chapter 3 for the DYNTACS model and in chapter 5 for IUA. These comparisons center on the overall trial outcomes and on the patterns of individual weapons firings and engagements as recorded in the field and extracted from model runs. The elementary supporting data, a time-phased record of each firing and its result from the field and from each model replication, are contained in appendix E. Detailed comparisons are limited to two trials, and their major restriction is a lack of replication from the field trial and the resultant inability to gauge the variability of observed results.

d. Additional Model Considerations. The reviews of model operation in light of general field tendencies and the critical model reviews are contained in chapter 4 for the DYNTACS model and chapter 6 for IUA.

e. Findings, Conclusions, and Recommendations. Findings, conclusions, and recommendations are contained in chapter 7.

CHAPTER 2

APPROACH TO MODEL VERIFICATION

2-1. GENERAL. The TETAM field experiment provided more detailed data on weapon interactions in dynamic situations with a greater aura of realism than had been available previously for model validation. The availability of this unique data base called for development of a model verification approach that took full advantage of the data.

2-2. TETAM VALIDATION APPROACH.

a. Nature of the Experiment. Experiment 11.8 represents a middle ground between computer simulations and real world battles. Since the experiment involved real soldiers operating real hardware, it had an aura of realism that could not be attained within a computer. Obviously, many artificialities had to be introduced into the field equipment to represent casualties and destruction of equipment. Thus, the field experiment was actually another representation or simulation of real combat; and the assumption is made that by virtue of its use of real people and hardware, it is closer to the real world than a computer model that does not use real people or hardware. When the Field Experiment 11.8 data were viewed in this light, it was apparent that the TETAM verification effort should take the form of a model comparison study, with the field experiment being used as the basis of comparison; that is, as the model assumed to be more nearly valid.

b. Restrictions to the Approach. Two major restrictions were encountered in attempting to conduct the model verification as a model comparison study, using the field experiment as a basis of comparison.

(1) First, the various field experiment trials did not provide a well-defined set of parametric variations necessary to sensitivity testing in a model comparison.

(2) The second major restriction was a lack of replication in the field experiment.

(a) Over 30 field battles were conducted using various defensive and threat tactics during Phase III of the field experiment. An analysis was performed to determine which trials were replications of a particular battle situation. It was believed that after a replication set had been identified, the variability of the field results could be estimated for comparison with the variability of model results. The following criteria were used to classify two or more trials as replications of the same battle:

1. Defender positions in replicated trials should be the same, or they should at least have the same general characteristics, such as elevation and fields of view.

2. Attackers in replicated trials should perform the same tactic (i.e., either fire and move or rapid approach), use the same approach routes, and be organized in generally the same manner, particularly for ATGM employment.

(b) An extensive analysis of the defensive positions using maps and aerial photographs showed that none of the trials for which usable data existed were replications of the same battle situation.

(c) Another analysis was conducted on threat tactics by plotting the movement of each attacker vehicle. The plots indicated that for most of the trials the attacker tactics were abandoned. Comments made by participants in the trials indicated that the tactics were abandoned because the attackers became disoriented when taken under effective ATM fire.

(d) Consequently, it was impossible to identify trials that were replications of the same battle situation; and the inherent variability of the field results could not be established. This finding led to a view of the experimental data as being composed of many unique observations (trials) from a relatively large number of different situations rather than several observations from a relatively small set of well-defined situations, as had originally been expected. As a result it was necessary to select field trials that appeared most useful in terms of model verification and to restrict the use of statistical techniques in the comparison.

c. Diversification of Approach. A three-part approach to model verification was followed. First, detailed comparisons of model results and field experiment outcomes were made for selected trials of the field experiment. Second, general tendencies of the field experiment were noted, and model assumptions and treatment of combat processes were reviewed in light of these tendencies. Third, the models were subjected to critical review, which resulted in identification of model design aspects that lead to intuitively unacceptable or unrealistic treatments of combat.

(1) Comparisons with individual field trials. Of the three general methods selected for model evaluation, the most promising was direct comparison between model and field trial results generated from the same scenario. This procedure would provide detailed, quantitative comparisons between model and field response data. In application this procedure proved to be weak, primarily because of the lack of replication among the various field trials. As discussed in paragraph 2-2b above, an in-depth examination of the sets of field trials that CDEC referred to as treatment combinations revealed major differences between the trials within a given set; that is, no two trials within any given set were similar in all important respects. Major differences were observed from trial to trial in the defensive coverage obtained by antitank weapons, in the attackers' use of terrain, in the initial force

sizes and mixes, in the degree of control over tactical execution, and in terms of the actual movement or firing tactics implemented. It was concluded that replication did not exist in the field trials in any meaningful sense. Thus, the direct and detailed comparisons originally envisioned came to involve comparing one field trial realization to a set of model replications of the same scenario. Without replication of the field trials this analysis provided only gross indications of whether model and field results could be considered similar.

(2) Analysis of general tendencies. The second procedure used in model evaluation was straightforward. It involved identification of the principal tendencies of the TETAM field trials of value in model evaluation. These tendencies were studied in light of model assumptions and how the models behaved under certain circumstances. These comparisons identified a number of questionable areas within each model.

(3) Identification of model areas of concern. The final procedure used in model evaluation was also straightforward. It involved being alert for suspicious areas encountered with model logic or modeling procedures. As these areas were identified, they were recorded and subsequently evaluated judgmentally.

2-3. INTRODUCTION TO DETAILED COMPARISONS.

a. Scenarios for Model Input.

(1) Two trials, 34 and 96, were selected for modeling.

(a) Trial 34. Trial 34 was a well executed rapid approach tactic across a medium front against a deliberate defense. The control of the maneuver of the various elements of the attacking force was good enough to warrant the selection of this trial as a "shakedown" of the model setup procedures.

(b) Trial 96. Trial 96 was a fire and movement tactic on Site A conducted against a deliberate defense. The attack was well executed and was relatively rapid across areas where the attackers were often killed in other trials. As a result, the attack did not degenerate into individual unit actions as occurred in most other trials.

(2) Because of the large input requirements of the models, several different means were used for describing the scenarios of the trials. An analysis of the area of operations was developed to describe both the terrain and the possible courses of action used to conduct the attacks. An analysis of defensive positions was developed to describe each of the positions used during subphases IIIB and IIIE and to provide some indication of defender capabilities and vulnerabilities from each position. Neither of these documents describes the exact setup for any particular experiment. These specifications generally were developed from the recollections of two Army officers who were data controllers at CDEC at the time, and they provide a general overall estimate of the situation.

The detailed description of the trials was provided in operations orders, wherein the organization of the attackers and defenders including platoon and company organizations, axes of advance, and so on were documented. One operations order was developed to describe the actions of each force for each trial. In addition to these operations orders, general comments recorded by the controllers who observed the trials as they were executed were included. An overall description of the trial from start to finish on a minute-by-minute basis was also given. Finally, both the attacker routes and the attacker and defender firings were plotted on 1:25,000 map sheet, included with the operations orders. These trial description data are contained in appendix D.

c. Model Preparation for Detailed Comparisons. Three general areas were involved in preparing for detailed comparisons: identification of no-test areas for which meaningful comparison would be impossible, model logic modifications, and development of detailed model input data.

(1) Test areas. As preparations for the detailed comparisons progressed, it became obvious that the number of aspects of tank-antitank battles for which meaningful comparisons could be made was severely limited. The aspects identified as desirable for comparison are discussed below in terms of whether they could be developed as test areas for consideration in detailed comparisons, partial test areas, or no-test areas. This categorization refers only to the detailed comparisons. Inability to make a detailed comparison does not imply that it was impossible to reach a conclusion on a given aspect in terms of general field trial indications or a critical model review.

(a) General outcome. The general outcomes of field trials were considered amenable to comparison with model results in terms of overall battle losses.

(b) Attacker-defender intervisibility. Intervisibility was a partial test area to the extent that engagements in the field implied the existence of intervisibility. Since intervisibility was the subject of earlier stages of the TETAM Model Verification Study, the free play stage allowed a check on the appropriateness of model changes that were indicated in the earlier study phases.

(c) Movement of attacking forces. Attacker movement was considered a no-test area for the detailed comparisons. The potential items for comparison would have been general routes and movement rates of units, specific routes and rates of individual vehicles, and, by implication, tactical formations maintained by units.

1. For the IUA model, unit routes are input, and individual vehicle speed is limited by vehicle and terrain characteristics. There is no meaningful unit formation concept within the model, with unit speed being the same as individual vehicle speeds and individual routes not being meaningfully discriminated from the input unit routes. Thus, there is little of substance in IUA upon which comparisons of

attacker movement could be based. Since it was obvious on review of the field experiment that movement rates in the field were not explained by vehicle and terrain limitations, IUA was forced to move its units at the same average speed observed in the field by adjusting terrain and vehicle capability data along the movement paths. Thus, the comparison of movement rates was intentionally sacrificed. Giving up this comparison allowed the study team to force IUA to track the field in its time and space relation, thus facilitating comparisons of the engagement process.

2. In the DYNTACS model, unit movement routes, unit speed, and formations are required input data; and individual routes and speeds derive through an assumption of strict adherence to the geometric patterns of input formations. Thus, to attain a comparable time and space relation and facilitate comparisons of the engagement process, direct movement comparisons were not attempted. Rather, data were developed based on review of detailed field results to force model elements to move generally as movement had taken place in the field.

(d) Target acquisition. Target acquisition was an area for comparison, with the constraint that detections in the field had been recorded only when they led to target engagement. Thus, the direct comparisons could only deal with acquisition in the sense that acquisition is implicit in engagement.

(e) Target handoff. The models do not treat target handoff explicitly, nor did handoffs appear to be effective in the field. Therefore, target handoff was considered a no-test area.

(f) Target assignment. The models deal with target selection by an individual weapon on the basis of input rules. Review of the field experiment indicated a lack of specific engagement rules provided to the participants, leading to the conclusion that the individuals selected targets based on individual (but never explicitly defined) rules. In both the model and the experiment, therefore, individual target selection occurred with little apparent coordination, rather than actual target assignment. A reasonable comparison thus was considered possible.

(g) Target engagement/kill. Given target selection, comparisons of target engagement in terms of times were considered practical. Target kills, however, were an experimental artificiality; and this was deemed a no-test area. The same algorithm and input data used in the field to determine target kills given a shot were incorporated into the models in an attempt to avoid spurious differences.

(h) Combat intelligence. No meaningful comparisons of combat intelligence, apart from the acquisition aspect, could be devised; and this was considered a no-test area.

(i) Communications. No meaningful data to support detailed comparisons were available from the field.

(j) Supporting fires. No meaningful data were available from the field.

(2) Model modifications. Model logic changes were made to facilitate the detailed comparisons. Changes were made either as corrections to the model logic intended to be permanent changes or as temporary changes to avoid spurious differences between model and field results.

(a) DYNTACS changes.

1. The DYNTACS intervisibility algorithm was changed. The intervisibility portion of the TETAM Model Verification Study indicated that portrayal of intervisibility, at least for the HLMR sites, was improved with a stochastic treatment of vegetation; and this change was incorporated into the DYNTACS model for free play comparisons. Such modification should be maintained for future DYNTACS applications.

2. The same algorithm used in the field experiment to determine the results of a firing was incorporated into the DYNTACS model for the free play comparisons. Since this area was treated artificially in the field experiment, the experiment offers no information to compare with results of the original DYNTACS algorithm in any meaningful sense. Thus, the modification is temporary and was made in an attempt to avoid spurious differences.

3. The movement logic in DYNTACS was revised to permit a more continuous representation of the motion of maneuver unit leaders. The original logic forced these elements to remain motionless for unpredictable amounts of time along their movement trace due to the model's event sequencing logic, which used an arbitrary time for the length of movement events. (The time is an input value, which typically has been set to 30 seconds for DYNTACS applications.) When maneuver unit lead elements reached certain points along the routes, selected within the model logic, the element hesitated at those points for the remaining duration of a movement event. Since these points have no clear tactical significance, the halts in movement were not meaningful. Logic was changed to allow a movement event to end when the element reached such a point, making motion more continuous.

4. A minor coding correction was made in the movement controller to make treatment of phase lines consistent with model documentation.

(b) Changes to IUA.

1. The line-of-sight processor was changed to process an expanded terrain data base. The original version of IUA allowed a maximum of 1,000 triangles to be used in describing the terrain. This maximum was increased to 2,500 triangles.

2. The original IUA model calculated line of sight between points on an attacker route and the route objective point. The calculated line-of-sight condition was assumed to exist between all attackers at the route point and all defenders located at the route objective point. During the intervisibility phase of the model validation effort, it was found that this approximation was not of sufficient resolution to produce line-of-sight conditions existing at each of the defender locations. Consequently, model logic was changed to calculate line-of-sight between individual defender positions and the attacker route points. This change should be maintained in future model applications.

3. The IUA damage assessment routine not used during the model validation runs. It was temporarily replaced with code representing the same methods of damage assessment used by the CDEC computer during the field trial.

(3) Data preparation. The primary consideration was to describe conditions within the model to reflect as closely as possible the conditions that existed in the field. For example, data were developed to force the movements of individual weapons in the models to reflect the routes and speeds actually followed in the field, to the extent that such information regarding the field trials was available and control of model movement was possible. The information available from the field is discussed in appendix D, and development of model input data is reviewed in appendix A.

2-4. SUMMARY. The TLTAM field experiment provided a body of empirical information with an aura of realism and in a detail generally not available for model validation efforts. The approach to model verification using this unique basis of comparison developed along three lines. First, detailed comparisons of model results and the outcomes of selected field trials were completed. As detailed review of the field experiment progressed, a lack of replication became apparent and it became necessary to restrict the extent of detailed comparisons in light of this characteristic of the basis of comparison. As a result, detailed comparisons were limited to two field trials, and these comparisons were limited to review of the target engagement process and overall outcomes. Major aspects of the action, such as attacker movement, were identified as no-test areas for the detailed comparisons. The second line of investigation involved the identification of certain apparent tendencies within the field trials and a discussion of model capabilities in view of these apparent tendencies. Finally, the models were subjected to critical review to identify weak areas not necessarily relatable to the field experiment.

CHAPTER 3

DETAILED DYNTACS COMPARISONS

3-1. INTRODUCTION.

a. This chapter contains the detailed comparisons of DYNTACS and field experiment results for the situations established in CDEC Experiment 11.8 Trials 34 and 96. These trials are two of the better-controlled experiments for which data are available, and they represent the two modes of attacker tactics used in Experiment 11.8. During Trial 34 attackers executed a rapid approach tactic, and in Trial 96 they used a fire and movement tactic.

b. Model runs were made under the constrained conditions discussed in chapter 2. Biefly, these constraints involved development of the model input data to cause attacking elements in the model to follow movement traces observed in (or projected from) the field experiment data, to cause attacking elements to move on these traces at rates observed in the field, and, insofar as possible, to apply the same fire control policies apparently in effect in the field. Additionally, the casualty assessment algorithms and data used in the field execution of Experiment 11.8 were used, replacing the assessment logic normally found in the model. Under these constraints, model representations available for meaningful scrutiny were limited to those involved in the target detection/acquisition/engagement sequence.

c. The approach taken to these comparisons derives from an inability to identify sets of field experiment trials that were replications of the same basic situation. Each field trial is viewed as one potential outcome of the unique situation established in that trial, and this outcome is compared to a set of 10 model replications produced by establishing the same situation within the model. The comparisons are oriented to exploring the following questions:

(1) Can the field outcome be viewed as a sample from the population represented by the set of model replications?

(2) Where differences between model and field results are noted, is there a logical explanation for the difference that leads to acceptance of the model outcome?

(3) Where differences between model and field results are noted, is there a logical explanation for the difference that points to a potential problem area in the model?

3-2 TRIAL 34 COMPARISONS.

a. Base Case. In the following discussions, the initial comparisons between model and field results are referred to as the base case. Comparisons made subsequent to model or input modifications are referred to as modified cases.

(1) Situation portrayed. Model input data were developed to portray the general situation observed in the field experiment. The attacking force of seven tanks, two ATGM, and two ICV advanced on a single axis with the ICVs on the attacker's left, tanks spread across the axis, and ATGMs taking up an overwatch position on the right. The defending force was composed of two TOWs, one Shillelagh, and one DRAGON. The players' interpretations of the rapid advance tactic, for this trial, caused the tank crews to concentrate solely on rapid movement toward the defensive area, resulting in only two tank gun firings throughout the trial. Thus, the tanks and unarmed ICVs presented an essentially passive target array in the field. To portray this condition, model input data were used that prevented the tanks from firing until they were within a few hundred meters of the defender positions. The attacking force task organization, routes of advance, and formations were developed by review of the field trial data (see appendix D). These same organizations, routes, and formations were used in the model runs. Additionally, advance rates used in the model were derived from the field data, causing the model attack vehicles to move across the field and reach critical points, particularly the ATGM overwatch position, with a phasing similar to that noted in the field trial. Battles were stopped in the model when any element of the attacking force reached the area of the trial termination line used in the field.

(2) Battle outcomes. Table 3-1 contains the gross outcome of each of 10 DYNTACS replications and the field trial in terms of surviving force strengths. The Blue (defender) force in the field lost only the Shillelagh. This result is well represented in the set of model outcomes. In terms of residual Red (attacker) strength, the field results could be viewed as a sample of the model outcomes with the exception of surviving ICVs. Both ICVs generally were lost in the model, while both ICVs survived in the field trial. Although model and field results are not in strong disagreement, the field outcome would be a relatively rare model outcome, with the attacking force generally doing better in the field.

(3) Weapon activity. The basic firing data for all model runs and for the Experiment 11.8 trial are contained in appendix E. A summary of rounds fired, targets engaged, and kills by each defender weapon is shown in table 3-2; and a summary of attack weapon activity is in table 3-3. Field experiment data include "unpaired" firings; that is, firings that occurred in the field but for which the target was not known. Comparability of field and model results for each defender weapon and attacker weapon type is discussed below.

(a) TOW 18. A comparison of firing patterns for field TOW 18 and the model is shown in figure 3-1. Impact points for rounds fired by TOW 18 are shown for all 10 model replications (designated by +) and for the four paired field firings (designated by □). Attacker advance routes and weapons assigned to these routes are also shown in this figure.

Table 3-1. DYNTACS Trial 34 Base Case Outcomes

DYNTACS Replication Number	Number of Red Weapons Surviving (T62 - ATGM - ICV) (Initial strength 7 2 2): Force Stopped	Some Power at Objective	Much Power at Objective	Nr Blue Wpn Surv (TOW - Shill - DGM) Initial Strength 2 1 1
1	-	-	3 2 0	2 0 1
2	-	-	4 2 0	1 0 1
3	-	-	3 2 0	2 0 0
4	-	-	3 2 1	2 0 1
5	-	1 1 0	-	2 0 1
6	-	-	4 2 0	1 0 1
7	-	-	4 2 1	1 0 1
8	-	2 2 0	-	2 0 1
9	-	-	3 2 1	1 0 1
10	-	1 1 0	-	2 1 0
Exp. 11.8	-	2 2 2	-	2 0 1

Table 3-2. DYNTACS Trial 34 Base Case - Defender Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		T62	ATGM	ICV	Total*	T62	ATGM	ICV	Total	T62	ATGM	ICV	Total
TOW 18	DYNTACS												
	Mean	0.6	0.0	1.6	2.2	0.4	0.0	1.2	1.6	0.4	0.0	0.8	1.2
	Std Dev	0.8	0.0	1.1	1.2	0.5	0.0	0.8	0.8	0.5	0.0	0.6	0.6
	Exp 11.8	3	0	1	5	1	0	1	2	1	0	0	1
TOW 19	DYNTACS												
	Mean	3.9	0.1	1.2	5.2	2.8	0.1	1.1	4.0	2.1	0.1	0.7	2.9
	Std Dev	1.5	0.3	0.9	1.8	1.3	0.3	0.7	1.6	1.9	0.3	0.6	1.6
	Exp 11.8	7	0	0	8	5	0	0	5	4	0	0	4
Shillelagh 20	DYNTACS												
	Mean	3.0	0.2	0.5	3.7	1.5	0.1	0.3	2.0	1.2	0.1	0.2	1.5
	Std Dev	1.9	0.3	0.7	1.9	0.7	0.4	0.5	0.7	0.6	0.4	0.3	0.7
	Exp 11.8	4	0	0	4	2	0	0	2	0	0	0	0
DRAGON 23	DYNTACS												
	Mean	2.1	0.0	0.0	2.1	1.1	0.0	0.0	1.1	0.5	0.0	0.0	0.5
	Std Dev	1.2	0.0	0.0	1.2	0.6	0.0	0.6	0.6	0.5	0.0	0.0	0.5
	Exp 11.8	4	0	0	4	2	0	0	2	0	0	0	0
Total	DYNTACS												
	Mean	9.6	0.4	3.2	13.2	5.8	0.3	2.6	8.7	4.2	0.2	1.7	6.1
	Std Dev	2.1	0.7	1.5	3.2	1.1	0.5	1.0	1.8	1.2	0.3	0.5	1.6
	Exp 11.8	18	0	1	21	10	0	1	11	5	0	0	5

* Includes unpaired firings

Table 3-3. DYNTACS Trial 34 Base Case - Attacker Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		TOW	Shill	DGN	Total*	TOW	Shill	DGN	Total	TOW	Shill	DGN	Total
T62	DYNTACS												
	Mean	0.3	0.0	0.0	0.3	0.3	0.0	0.0	0.3	0.3	0.0	0.0	0.3
	Std Dev	0.4	0.0	0.0	0.4	0.4	0.0	0.0	0.4	0.4	0.0	0.0	0.4
	Exp 11.8	0	0	0	2	0	0	0	0	0	0	0	0
ATGM	DYNTACS												
	Mean	0.5	1.8	4.2	6.5	0.2	1.2	1.0	2.4	0.1	1.0	0.2	1.3
	Std Dev	1.1	0.9	4.4	5.2	0.4	0.4	0.7	0.8	0.3	0.0	0.4	0.5
	Exp 11.8	0	3	2	8	0	1	2	3	0	1	0	1
Total	DYNTACS												
	Mean	0.8	1.8	4.2	6.8	0.5	1.2	1.0	2.7	0.4	1.0	0.2	1.6
	Std Dev	1.0	0.9	4.4	4.9	0.5	0.4	0.7	0.7	0.5	0.0	0.4	0.5
	Exp 11.8	0	3	2	10	0	1	2	3	0	1	0	1

* Includes unpaired firings

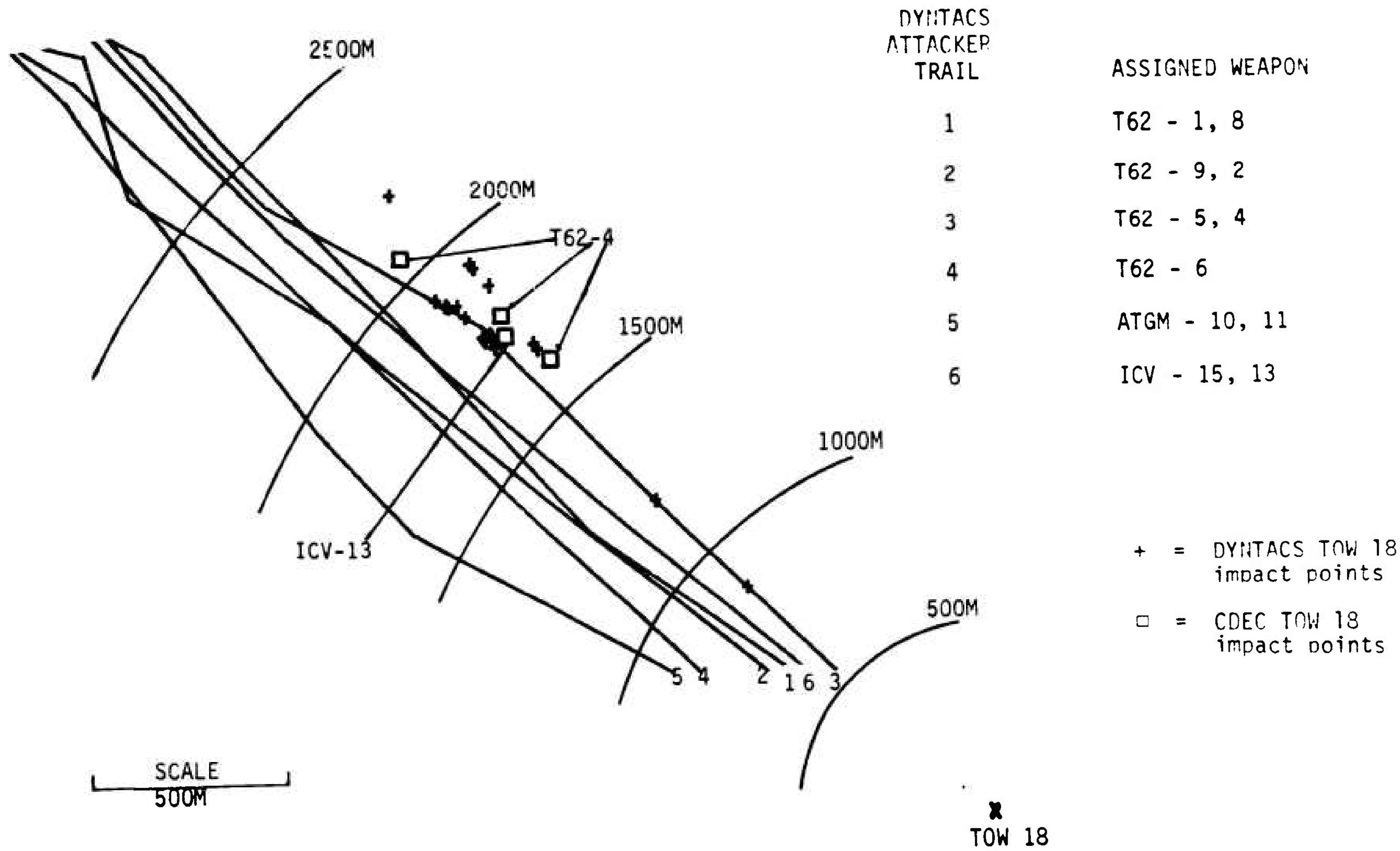
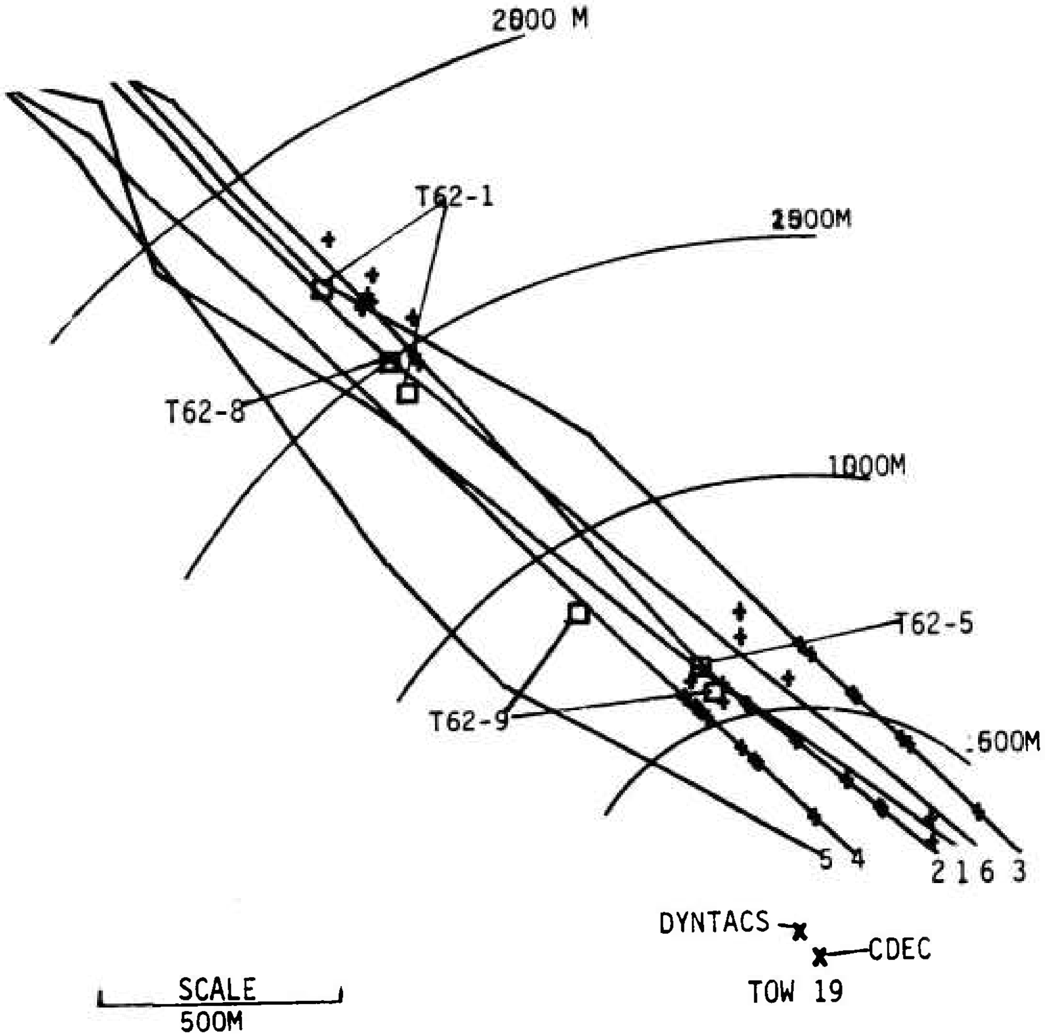


Figure 3-1. DYNTACS Trial 34 Base Case - Impact Points of TOW 18 Rounds

In the field, TOW 18 engaged one tank, scoring a kill with three rounds, and fired one round at an ICV. One unpaired firing was also recorded for TOW 18. The tank engaged by TOW 18 and all ICVs were on the extreme left of the attacker formation, suggesting either limited intervisibility from the TOW 18 position or fire control restrictions. In the model, TOW 18 engaged and killed the leftmost attacker tank with one or two rounds in 4 of the 10 replications. TOW 18 also engaged one or both of the ICVs in 8 of the 10 replications, firing one or two rounds per ICV engagement and scoring a kill on two-thirds of the engagements. In the model, TOW 18 was clearly restricted to the extreme left of the attacker formation by intervisibility. Assuming that the weapon was in fact constrained by intervisibility in the field, the model and field results are consistent except for the apparent reluctance to continue firing at the ICVs in the field.

(b) TOW 19. TOW 19 was the most active weapon in the field, engaging five attacker tanks and scoring a first or second round kill on four tanks. This weapon fired eight rounds, of which one was unpaired, and is believed to have fired exclusively at tanks although the target of the unpaired firing is unknown. Two of the attacking tanks killed by TOW 19 had been fired at by another defender weapon prior to the kill by TOW 19. In the model runs, TOW 19 typically engaged two or three attacking tanks and one of the threat ICVs. This result was sufficient to make TOW 19 the most active weapon in the model runs but still left the weapon less active in the model than in the field. The primary engagement areas for the field TOW and model TOW 19 are shown in figure 3-2. The failure of other weapons in the field to kill the targets is a partial explanation of this difference. It is also possible that in engaging the ICVs that were ignored in the field, the model TOW 19 may have missed opportunities for tank detection and engagement.

(c) Shillelagh 20. The Shillelagh in the field had good coverage of the avenue of approach used by the attacking force but was relatively inactive. It fired two rounds at each of two tanks and scored no kills. These four firings covered a time span of slightly over 6 minutes, after which the Shillelagh sustained a kill by one of the threat ATGMs at about 12.5 minutes into the trial. The Shillelagh in the model fired an average of 3.7 rounds, engaging an average of 2 targets and scoring an average of 1.5 kills. The Shillelagh concentrated on tanks in the model runs but also engaged an ICV or ATGM in 5 of the 10 replications. The model Shillelagh was killed by a threat ATGM 8 or 9 minutes into the battle and was only active (period from first round fired by Shillelagh to kill by ATGM) for 1 to 3 minutes. The early kill of the model Shillelagh is reflected by its firing patterns in figure 3-3. The model Shillelagh was killed after engaging tanks and ATGMs at a range of 2,200 to 2,900 meters while the field Shillelagh survived to engage a T62 at 1,400 and 800 meters.

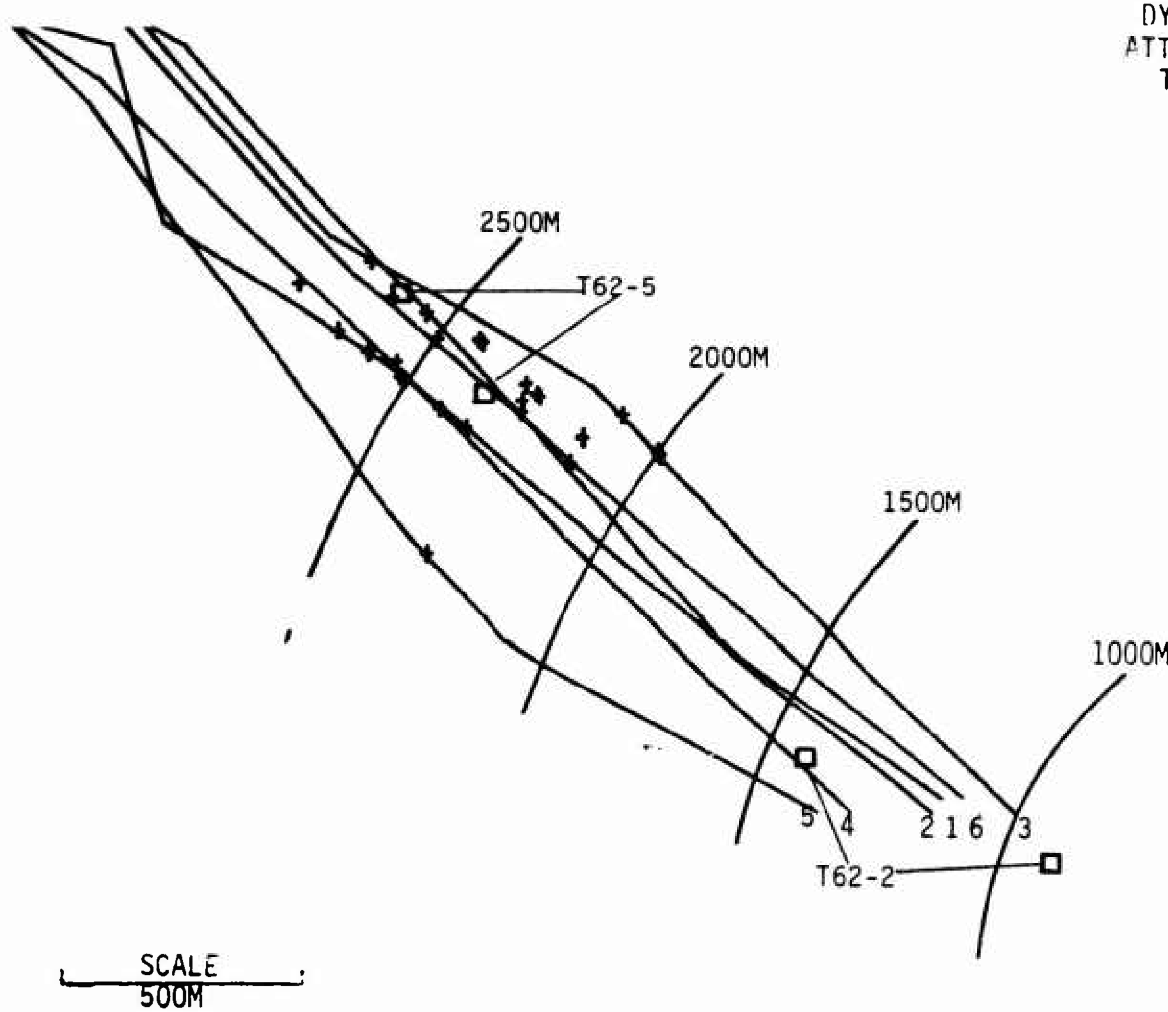


DYNTACS ATTACKER TRAIL	ASSIGNED WEAPON
1	T62 - 1,8
2	T62 - 9, 2
3	T62 - 5, 4
4	T62 - 6
5	ATGM - 10, 11
6	ICV - 15, 13

+ = DYNTACS TOW 19 impact points

□ = CDEC TOW 19 impact points

Figure 3-2. DYNTACS Trial 34 Base Case - Impact Points of TOW 19 Rounds



DYNTACS ATTACKED TRAIL	ASSIGNED WEAPON
1	T62 - 1, 8
2	T62 - 9, 2
3	T62 - 5, 4
4	T62 - 6
5	ATGM - 10, 11
6	ICV - 15, 13

+ = DYNTACS Shillelagh 20 impact points

□ = CDEC Shillelagh 20 impact points

CDEC ✕ ✕ DYNTACS
Shillelagh 20

Figure 3-3. DYNTACS Trial 34 Base Case - Impact Points of Shillelagh 20 Rounds

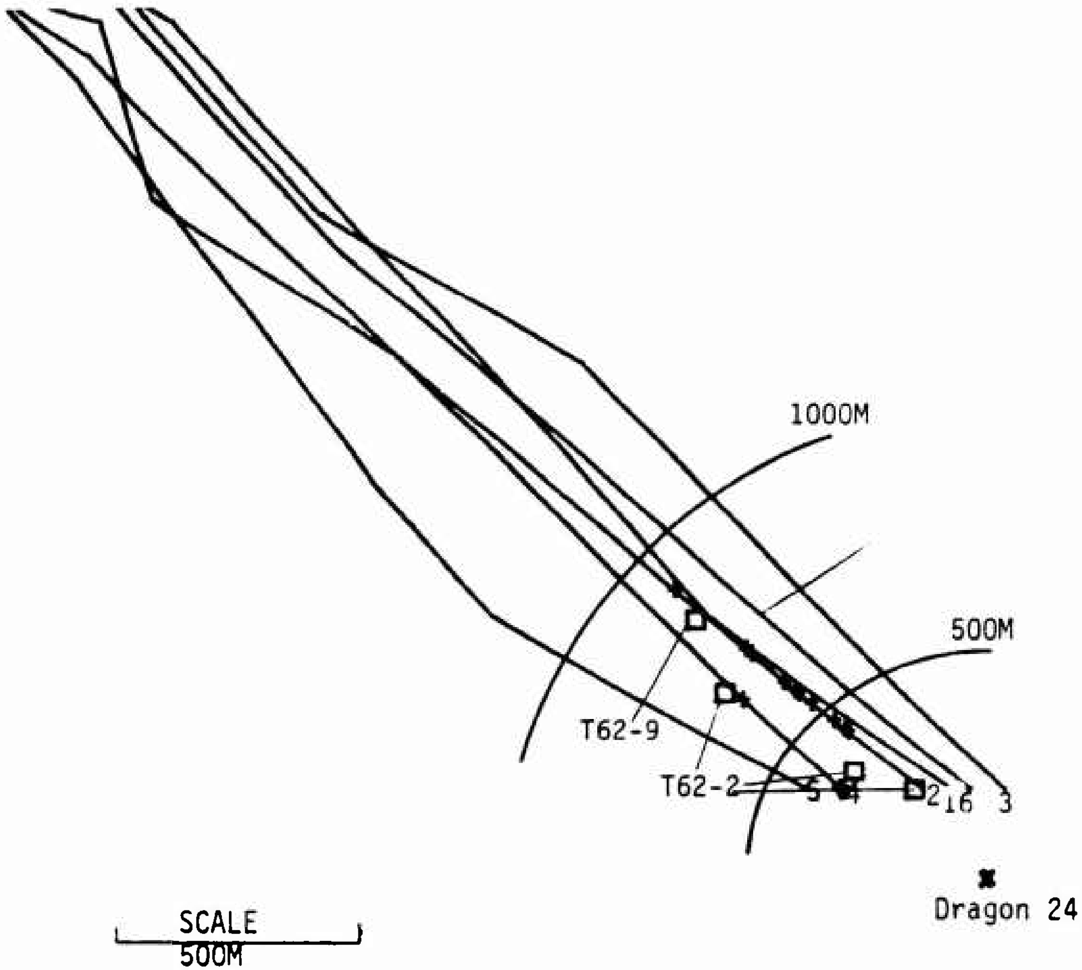
(d) DRAGON 24. In the field, DRAGON 24 fired a total of four rounds at two tanks and scored no kills. The DRAGON was only active for a period of 3 minutes. An interesting parallel is found in the model. The DRAGON in the field fired its opening round at threat tank 9, 9 minutes into the trial, but lost acquisition during missile flight. In the model, the DRAGON typically fired its opening round at the same target 9.5 minutes into the trial and did not lose acquisition. In the one model replication where the DRAGON engaged tank 9 earlier, intervisibility was lost during missile flight. The model DRAGON inevitably fired its initial round at tank 9 if tank 9 survived long enough to reach the DRAGON firing zone. In the field, tank 9 was killed by a different weapon (TOW 19) shortly after the DRAGON's abortive opening round, and the DRAGON shifted its attention (three shots) to a second tank. In the model, the DRAGON tended to remain on tank 9, shifting to a second tank on only two of the eight replications in which it initially engaged tank 9. The initial and subsequent model firings against tank 9 may be noted in the field/model shot patterns in figure 3-4. When the DRAGON did not engage tank 9 (two replications) it did engage one other tank.

(e) ATGM. In the field, the threat ATGMs reached the area of their overwatch position 8 to 9 minutes into the trial but had some problem finding satisfactory firing positions (three of the first four ATGM rounds fired from this area were unpaired). After about 4 minutes of what appears to be ineffective "shuffling" in the overwatch area, the ATGMs engaged and killed the Shillelagh. In the model, the threat ATGMs reached the position at about the same time, promptly engaged the Shillelagh, and inevitably scored a first or second round kill. Having disposed of the Shillelagh, the ATGMs generally started off the overwatch position and engaged the DRAGON at ranges of 1,200 to 1,500 meters. The firings at the DRAGON generally were ineffective, with the number of rounds fired depending on trial duration. On two replications, TOW 19 was also engaged (at 1,000 meters).

(f) Tanks. In the field, tanks 8 and 10 each fired one unpaired round. In the model, tank 8 killed TOW 19 with one close-in shot (under 300 meters) in three replications. In the remaining replications, TOW 19 generally killed tank 8 with a close-in shot (under 500 meters). The interaction between these weapons corresponds in time and position to the unpaired firing by tank 8 noted in the field and a single round fired by TOW 19 with acquisition lost in missile flight.

(4) Discussion. The base case model and field results for Trial 34 are, on the whole, consistent. The following exceptions are noteworthy.

(a) The unarmed ICVs were consistently engaged and killed in the model, while they appear to have been ignored in the field. The field players may have passed up shots at the ICVs in anticipation of more



DYNTACS ATTACKER TRAIL	ASSIGNED WEAPON
1	T62 - 1, 8
2	T62 - 9, 2
3	T62 - 5, 4
4	T62 - 6
5	ATGM - 10, 11
6	ICV - 15, 13

+ = DYNTACS DRAGON 24 impact points

□ = CDEC DRAGON 24 impact points

Figure 3-4. DYNTACS Trial 34 Base Case - Impact Points of DRAGON 24 Rounds

lucrative targets. This may be a sound target selection technique; but its wisdom is questioned when the ICVs, which would be carrying infantry in the real world, are allowed to arrive unscathed within a few hundred meters of the defender positions, as occurred in the field trial.

(b) TOW 19 was less active in the model than in the field. This result is partially explained by the fact that the other weapons, particularly the Shillelagh, were ineffective in the field, thus leaving more slack for TOW 19 to pick up than was apparent in the model. It is also possible that by engaging the ICVs the model TOW 19 missed some opportunities to detect and engage tanks.

(c) In the model, the Shillelagh had a much higher rate of activity than was noted in the field (although final levels of activity are similar since the Shillelagh was killed much earlier in the model). Since the Shillelagh position provides good coverage of almost the entire axis of attack, ample opportunity for more activity should have been available in the field. The most plausible explanation for this disparity lies in the note made by the CDEC observer in the field regarding this weapon: "Poor gunner." It is assumed that a more proficient gunner would have been more active.

(d) Personnel manning the ATGMs in the field had obvious problems in providing a base of fire from their overwatch positions. In the model this action was accomplished with ease, resulting in consistent timely kills of the Shillelagh, which would have dominated the model battle had it survived longer.

(5) Preliminary conclusions. With a single exception, comparison results support the model's capability to represent the Trial 34 situation in the field. The single discrepancy is the model's apparent overstatement of the ability of the attack ATGMs to establish effective fires rapidly when moving into the overwatch position. The other discrepancies between model and field results are more logically explained in terms of the inept Shillelagh gunner in the field and the tendancy of the players to ignore the threat ICV as a target.

b. Modified Case.

(1) Basis of change. The possibility that, in engaging threat ICVs, defender weapons were losing opportunities to engage threat tanks was investigated. A set of DYNTACS runs was made in which the input data placed no priority on the threat ICV as targets.

(2) Results. The basic outcome and weapon activity summaries for this set of runs are contained in tables 3-4, 3-5, and 3-6.

Table 3-4. DYNTACS Trial 34 Modified Outcomes

DYNTACS Replication Number	Number of Red Weapons Surviving (T62 - ATGM - ICV) (Initial strength 7 2 2)			Nr Blue Wpn Surv (TOW - Shill - DGN) Initial Strength 2 1 1
	Force Stopped	Some Power at Objective	Much Power at Objective	
1	-	1 2 2	-	2 0 1
2	-	-	3 2 2	1 0 1
3	-	-	3 2 2	2 0 1
4	-	-	4 1 2	2 0 1
5	-	-	3 2 2	2 0 1
6	-	2 2 2	-	2 0 0
7	0 1 2	-	-	2 0 1
8	-	1 2 2	-	1 0 0
9	-	-	3 2 2	1 0 1
10	0 2 2	-	-	2 0 1
Exp 11.8	-	2 2 2	-	2 0 1

Table 3-5. DYNTACS Trial 34 Modified - Defender Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		T62	ATGM	ICV	Total*	T62	ATGM	ICV	Total	T62	ATGM	ICV	Total
TOW 18	DYNTACS												
	Mean	0.8	0.0	0.0	0.8	0.5	0.0	0.0	0.5	0.5	0.0	0.0	0.5
	Std Dev	0.9	0.0	0.0	0.9	0.5	0.0	0.0	0.5	0.5	0.0	0.0	0.5
	Exp 11.8	3	0	1	5	1	0	1	2	1	0	0	1
TOW 19	DYNTACS												
	Mean	5.1	0.0	0.0	5.1	3.4	0.0	0.0	3.4	2.4	0.0	0.0	2.4
	Std Dev	1.6	0.0	0.0	1.6	1.2	0.0	0.0	1.2	1.1	0.0	0.0	1.1
	Exp 11.8	7	0	0	8	5	0	0	5	4	0	0	4
Shillelagh 20	DYNTACS												
	Mean	4.0	0.2	0.0	4.2	2.3	0.2	0.0	2.5	1.6	0.1	0.0	1.7
	Std Dev	1.6	0.4	0.0	1.8	1.1	0.4	0.0	1.4	0.7	0.3	0.0	[illegible]
	Exp 11.8	4	0	0	4	2	0	0	2	0	0	0	0
DRAGON 23	DYNTACS												
	Mean	2.1	0.0	0.0	2.1	1.3	0.0	0.0	1.3	0.5	0.0	0.0	0.5
	Std Dev	1.7	0.0	0.0	1.7	0.8	0.0	0.0	0.8	0.7	0.0	0.0	0.7
	Exp 11.8	4	0	0	4	2	0	0	2	0	0	0	0
Total	DYNTACS												
	Mean	12.0	0.2	0.0	12.2	7.5	0.2	0.0	7.7	5.0	0.1	0.0	5.1
	Std Dev	3.5	0.4	0.0	3.6	1.6	0.4	0.0	1.8	1.3	0.3	0.0	1.5
	Exp 11.8	18	0	1	21	10	0	1	11	5	0	0	5

* Includes unpaired firings

Table 3-6. DYNTACS Trial 34 Modified - Attacker Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		TOW	Shill	DGM	Total*	TOW	Shill	DGM	Total	TOW	Shill	DGM	Total
T62	DYNTACS												
	Mean	0.2	0.0	0.0	0.2	0.2	0.0	0.0	0.2	0.2	0.0	0.0	0.2
	Std Dev	0.4	0.0	0.0	0.4	0.4	0.0	0.0	0.4	0.4	0.0	0.0	0.4
	Exp 11.8	0	0	0	2	0	0	0	0	0	0	0	0
ATGM	DYNTACS												
	Mean	0.1	2.2	2.8	5.1	0.1	1.2	0.9	2.2	0.1	1.0	0.2	1.3
	Std Dev	0.3	1.5	1.8	2.3	0.3	0.4	0.3	0.4	0.3	0.0	0.4	0.5
	Exp 11.8	0	3	2	8	0	1	2	3	0	1	0	1
Total	DYNTACS												
	Mean	0.3	2.2	2.8	5.3	0.3	1.2	0.9	2.4	0.3	1.0	0.2	1.5
	Std Dev	0.5	1.5	1.8	2.6	0.5	0.4	0.3	0.7	0.5	0.0	0.4	0.7
	Exp 11.8	0	3	2	10	0	1	2	3	0	1	0	1

* Includes unpaired firings

(3) Discussion. The result of the change was predictable. TOW 18, which could only engage on the extreme left of the attack formation, engaged and killed the extreme left tank half the time, as it had done in the base case. The DRAGON had not engaged ICVs in the base case, and the change had no effect on its engagement of tanks. TOW 19 and the Shillelagh, which had engaged ICVs in the base case, now engaged tanks at an increased rate. The increased number of tank engagements by an individual weapon was not significant, but the total effect--an increase in the average number of tank engagements by the force from 5.8 to 7.5--may be significant.

3-3 TRIAL 96 COMPARISONS.

a. Base Case.

(1) Situation portrayed. Trial 96 involved an attacking force of seven tanks, three ATGM, and three ICV organized into three balanced platoons of two tanks, one ATGM, and one ICV each attacking on parallel axes. The seventh tank, believed to be the company commander, accompanied the middle platoon. The defensive mix contained two TOW, one Shillelagh, and two DRAGONs. In the field experiment the battle developed along a distinct pattern in time as depicted in figure 3-5.

(a) The defensive force opened fire on the center platoon; and, in the course of 2.5 minutes, one TOW and the Shillelagh killed the three tanks and the ATGM with a total of four rounds. In this same span of time, the three center tanks fired three rounds, one at the Shillelagh and two unpaired. This activity is represented in figure 3-5 as Phase A of the battle, which resulted in two defender weapons wiping out the attacker's center platoon while all attackers were still beyond DRAGON range.

(b) About halfway through the destruction of the center platoon, the attacking platoon on the right opened fire. In a period of slightly over 5 minutes the two tanks fired a total of 15 rounds, all unpaired, and the ATGM fired 5 rounds at the Shillelagh, finally scoring a kill. This period of activity by the right platoon is represented as Phase B.

(c) Phase C, on the attacker's left, commenced about a minute after the center platoon had been destroyed. In Phase C one of the left tanks engaged and, after five rounds, killed one of the DRAGONS. This tank was in turn killed by the surviving DRAGON at about 6 minutes after the opening round. While this exchange was taking place, the threat ATGM was fired upon twice by the Shillelagh, suffering a mobility kill, and fired five rounds at the Shillelagh. Phase C ended when the ATGM on the left ceased fire, its target (the Shillelagh) having been killed by the ATGM on the right.

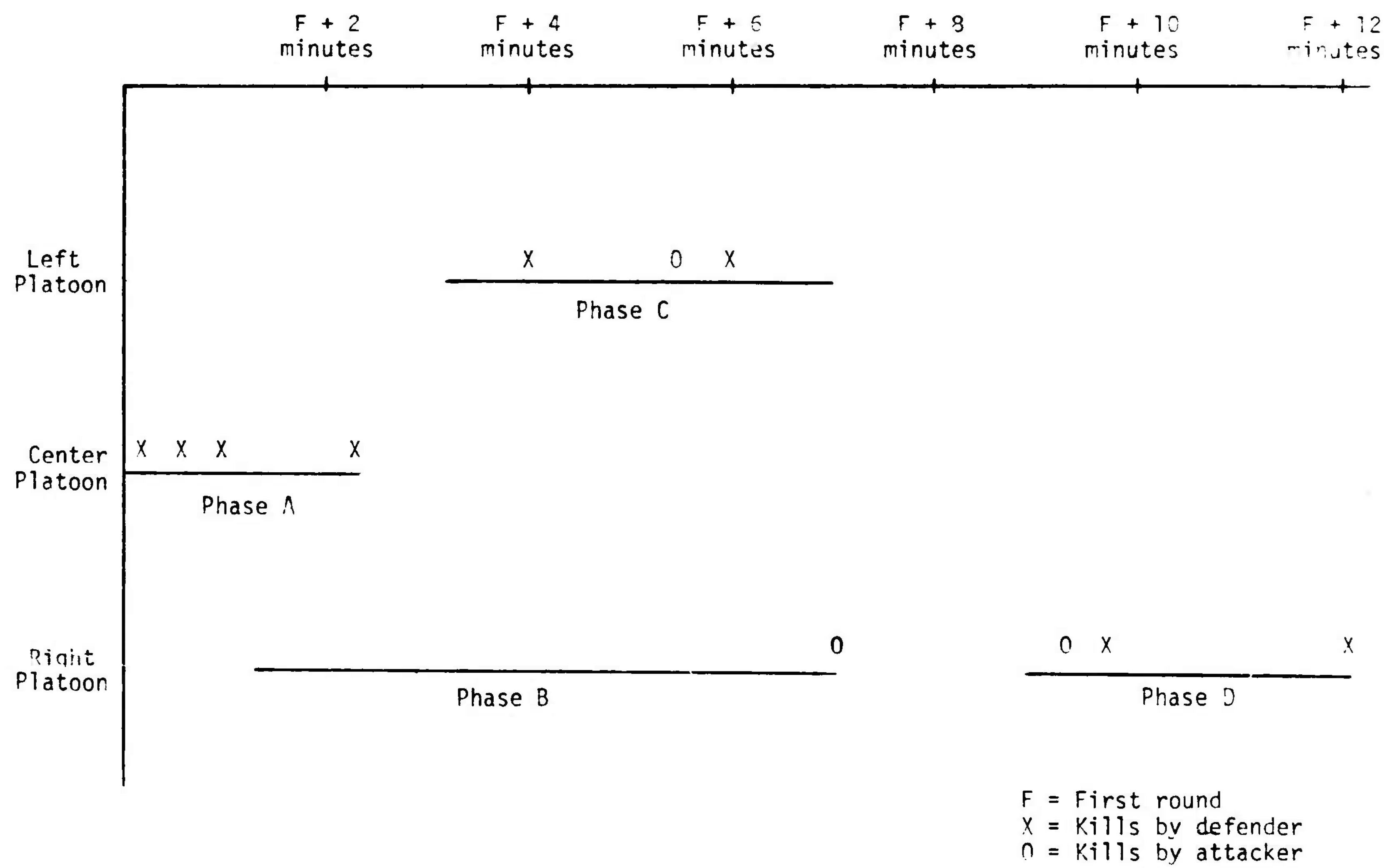


Figure 3-5. Trial 96 Development in the Field

(d) Phases B and C ended simultaneously, about 6.5 minutes after the first round was fired, with the silencing of the Shillelagh. At this point the attacker's center platoon had been destroyed, the left platoon was reduced to one tank, and the right platoon was intact. Also one DRAGON and the Shillelagh had been lost. An inactive period of about 2 minutes then occurred (actually, three unpaired firings by the remaining tank on the left took place in this lull).

(e) Finally, in Phase D, the tanks in the right platoon established line of sight to and rapidly did away with the remaining DRAGON. These tanks were in turn killed with two shots by the same TOW that had initiated the battle. The second TOW never fired and was never fired upon.

(f) The battle ended with one tank from the left platoon and the ATGM from the right platoon surviving. The other ATGMs had suffered mobility kills, and the ICVs had been ignored. The key to the defender's ability to deal with the attacking force appears to have been his early annihilation of the center platoon, which allowed the Red force to be defeated in detail, and the survivability of the one active TOW, which was never fired upon.

(2) Battle outcomes. The overall results of the ten DYNTACS base case replications and the field trial are shown in table 3-7. The following differences may be noted: both TOWs survived in the field, but one TOW was killed in each DYNTACS replication and both TOWs were killed in one replication; only one tank survived in the field, but two to four tanks survived in the model replications; no ICVs were killed in the field, but one or two ICVs were killed in each model replication. The first two differences are related in that survival of the active TOW in the field made the last two tank kills (Phase D of figure 3-5) possible. The tendency of players in the field to ignore ICVs as potential targets was mentioned in discussion of Trial 34, and the tendency appears again in Trial 96.

(3) Weapon activity. Summaries of rounds fired, targets engaged, and kills by the defender and attacker weapons are contained in tables 3-8 and 3-9. These results are reviewed below.

(a) TOW 18. This weapon was inactive in the field. In the model, this weapon had a low activity level, firing an average of one round per replication. Intervisibility apparently limited this weapon's activity. The weapon could find targets only in an area at about 2,200 to 2,400 meters from the TOW position or at the area of trial termination, in both cases at the extreme left of the attack formation. Both of these areas are shown in figure 3-6, which represents the impact points for model firings. The long range engagements were each a single shot,

Table 3-7. DYNTACS Trial of Base Case Outcomes

DYNTACS Replication Number	Number of Red Weapons Surviving (T62 - ATGM - ICV) (Initial strength 7 3 3)							Nr Blue Wpn Surv (TOW - Shill - DGN) Initial Strength		
	Force Stopped	Some Power at Objective			Much Power at Objective			2	1	2
1	-	2	2	1		-		1	0	0
2	-		-		4	1	2	1	0	0
3	-		-		3	1	1	1	1	0
4	-	2	1	1		-		1	0	0
5	-	2	1	1		-		1	1	0
6	-	2	1	2		-		1	0	0
7	-		-		4	2	2	1	0	0
8	-	2	1	1		-		1	1	0
9	-		-		4	2	2	1	0	0
10	-		-		4	2	1	0	0	0
Exp 11.8	-	1	1	3		-		2	0	0

Table 3-8. DYNTACS Trial 96 Base Case - Defender Weapon Activity

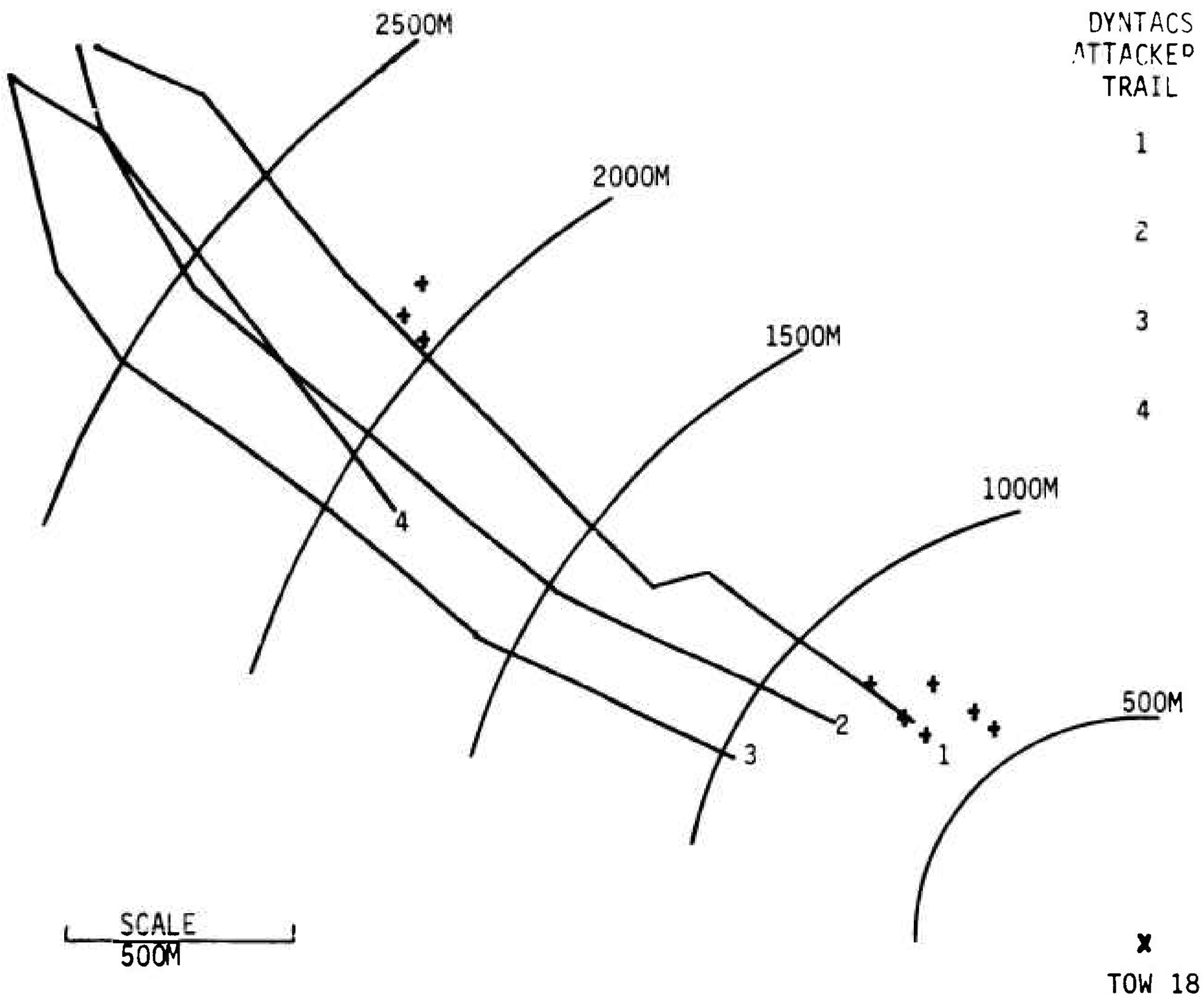
Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		T62	ATGM	ICV	Total*	T62	ATGM	ICV	Total	T62	ATGM	ICV	Total
TOW 18	DYNTACS												
	Mean	0.6	0.0	0.4	1.0	0.5	0.0	0.4	0.9	0.2	0.0	0.3	0.5
	Std Dev	0.7	0.0	0.5	0.8	0.5	0.0	0.5	0.7	0.4	0.0	0.4	0.7
	Exp 11.8	0	0	0	0	0	0	0	0	0	0	0	0
TOW 19	DYNTACS												
	Mean	1.6	1.2	0.0	2.8	1.3	0.5	0.0	1.8	0.9	0.0	0.0	0.9
	Std Dev	1.4	1.3	0.0	1.2	1.1	0.5	0.0	0.7	0.7	0.0	0.0	0.7
	Exp 11.8	5	0	0	5	4	0	0	4	4	0	0	4
Shillelagh 21	DYNTACS												
	Mean	2.7	2.4	1.3	6.4	2.0	1.5	1.1	4.6	1.8	1.0	0.7	3.5
	Std Dev	1.3	1.2	0.9	2.2	0.9	0.5	0.7	1.7	0.9	0.4	0.4	1.0
	Exp 11.8	2	3	0	5	2	2	0	4	1	2	0	3
DRAGON 23	DYNTACS												
	Mean	1.5	0.4	1.0	2.9	1.1	0.2	0.7	2.0	0.6	0.0	0.5	1.1
	Std Dev	0.9	1.2	1.1	1.9	0.7	0.6	0.6	1.1	0.5	0.0	0.7	0.7
	Exp 11.3	3	0	1	4	3	0	1	4	1	0	0	1
DRAGON 24	DYNTACS												
	Mean	1.8	0.4	0.5	2.7	1.1	0.3	0.4	1.8	0.5	0.0	0.0	0.5
	Std Dev	0.9	0.9	0.8	0.8	0.5	0.6	0.7	0.6	0.5	0.0	0.0	0.5
	Exp 11.8	0	0	0	0	0	0	0	0	0	0	0	0
Total	DYNTACS												
	Mean	8.2	4.4	3.2	15.8	6.0	2.5	2.6	11.2	4.0	1.0	1.5	6.5
	Std Dev	1.5	2.2	1.1	2.2	1.2	0.9	0.8	1.8	1.1	0.4	0.5	1.4
	Exp 11.8	10	3	1	14	9	2	1	12	6	2	0	8

* Includes unpaired firings

Table 3-9. DYNTACS Trial 96 Base Case - Attacker Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		TOW	Shill	DGN	Total*	TOW	Shill	DGN	Total	TOW	Shill	DGN	Total
T62	DYNTACS												
	Mean	3.2	3.2	3.3	9.7	1.4	1.2	2.1	4.7	0.7	0.2	1.6	2.3
	Std Dev	2.7	2.6	1.9	4.8	1.0	0.9	0.7	2.0	0.4	0.4	0.5	0.9
	Exp 11.8	0	1	7	29	0	1	2	3	0	0	2	2
ATGM	DYNTACS												
	Mean	1.0	2.3	1.4	4.7	0.4	0.9	0.7	2.0	0.4	0.5	0.4	1.3
	Std Dev	1.5	3.2	1.9	4.1	0.5	0.8	0.8	1.5	0.5	0.5	0.5	1.0
	Exp 11.8	0	10	0	10	0	2	0	2	0	1	0	1
Total	DYNTACS												
	Mean	4.1	5.5	4.7	15.3	1.9	2.1	2.7	6.7	1.1	0.7	2.0	3.8
	Std Dev	2.7	3.4	2.4	5.1	0.8	1.3	0.6	1.8	0.3	0.5	0.0	0.6
	Exp 11.8	0	11	7	39	0	3	2	5	0	1	2	3

* Includes unpaired firings



DYNTACS ATTACKED TRAIL	ASSIGNED WEAPONS	
1	ATGM - 10 T62 - 7	ICV - 14 T62 - 3
2	ATGM - 11 T62 - 2	ICV - 15 T62 - 8
3	ATGM - 12 T62 - 9	ICV - 13 T62 - 5
4	T62 - 1	

+ = DYNTACS TOW 18 impact points

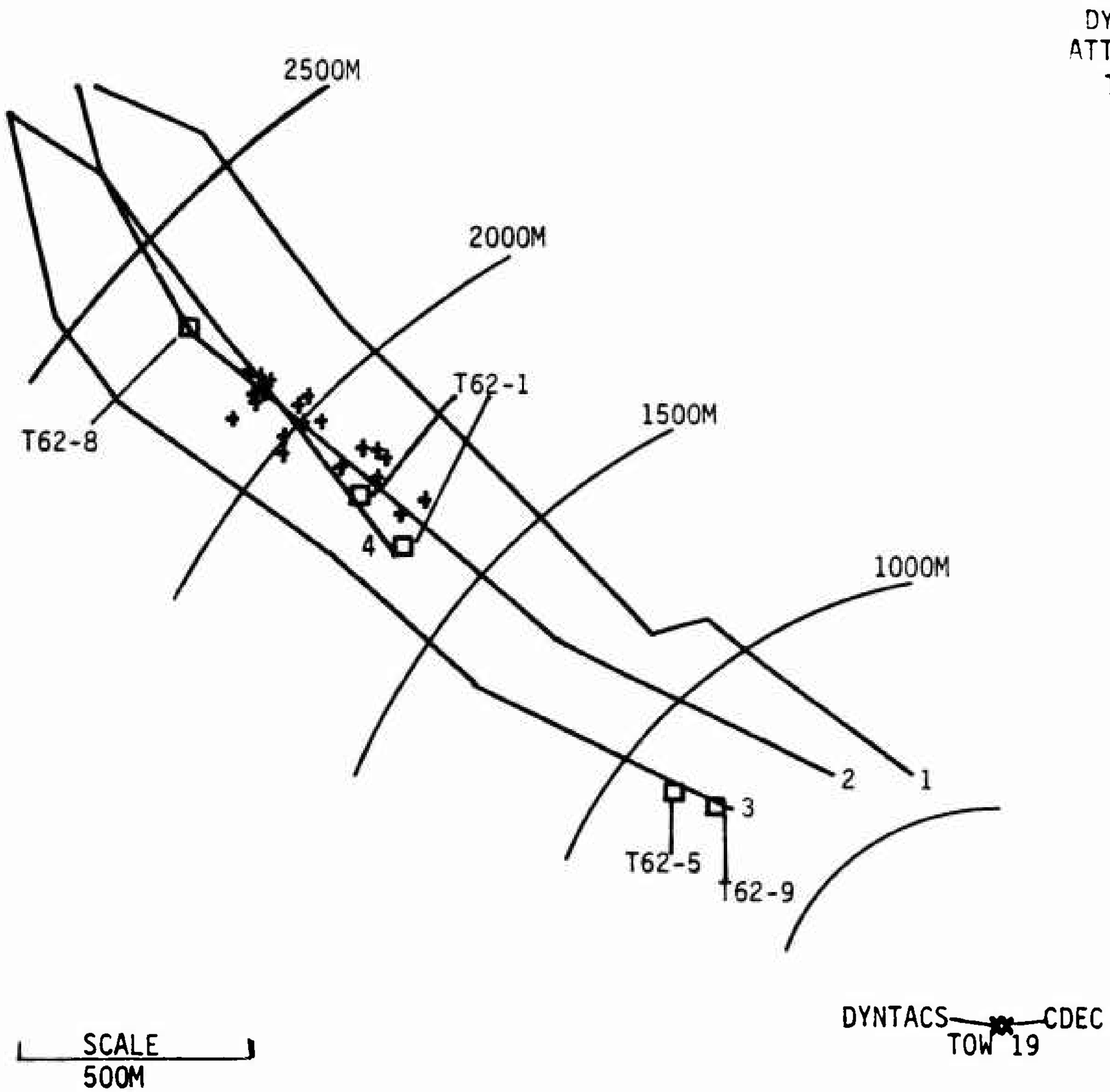
NOTE: CDEC TOW 18 did not fire

Figure 3-6. DYNTACS Trial 96 Base Case - Impact Points of TOW 18 Rounds

occurring once in each of three model replications, indicating a brief span of acquisition capability that could well have been missed by a player in the field. Whether the occasional closing shots occurring in the model were possible to the player in the field is unknown. It is known that the field trial position for TOW 18 was generally masked from the battle area, and this appears consistent with the model. It is possible that by trial termination the field player had lost interest and missed some closing shot opportunities.

(b) TOW 19. TOW 19 had two brief spans of activity in the field. It opened the battle in Phase A (figure 3-5), killing two of the center tanks with three rounds. After some 7 minutes of silence, TOW 19 closed the battle in Phase D, killing the two right tanks with two rounds. Model performance at the opening of the battle was similar, with TOW 19 engaging the center tanks or ATGM and firing an average 2.8 rounds at 1.8 targets. Figure 3-7 shows a comparison of field and model firings. This activity, however, constituted the total model battle for TOW 19 since, in the model, this TOW was receiving heavy return fire within a minute of firing its first round and was killed (in 9 of 10 replications) within 2 minutes of firing its first round. Thus, the model TOW 19 never survived long enough to fire the closing rounds noted in the field. With the possible exception of two unpaired firings by center tanks in the field, there is no evidence that TOW 19 was ever detected in the field.

(c) Shillelagh 21. In the field the Shillelagh opened fire along with TOW 19 on the attacking center platoon and killed one tank and the center ATGM (mobility kill) with its first two rounds. It fired a third round at one of the center tanks, which had already been killed, and then shifted its attention to the attacker's left platoon, scoring a mobility kill on that platoon's ATGM. Meanwhile the Shillelagh received fire from the threat ATGMs in both the attacker's left and right platoons and was finally killed after these ATGMs had each fired 5 rounds in a span of 5 minutes. It will be noted from the shot patterns of figure 3-8 that in the model the Shillelagh either opened fire with TOW 19 on the center platoon or, in 4 of the 10 replications, fired a single round at maximum range at the attacker's left platoon and then shifted fire to the center platoon. (The opening shots at the left platoon represent a very brief intervisibility "window," which probably was available in the field.) The model Shillelagh's first shot to the center was generally at the ATGM (7 of 10 replications) and within a minute of the TOW's opening round, as happened in the field. The Shillelagh continued to engage targets in the center until they were destroyed and then, given it had survived, engaged targets in the attacker's left platoon. Thus, the model sequence was similar to that in the field. The level of activity was higher in the model, with the difference attributable to the Shillelagh's consistent tendency to fire upon the center ICV. (ICVs apparently were ignored in the field.) Although the sequence and levels of action for the model are considered comparable to those in the field (taking into account the ICV

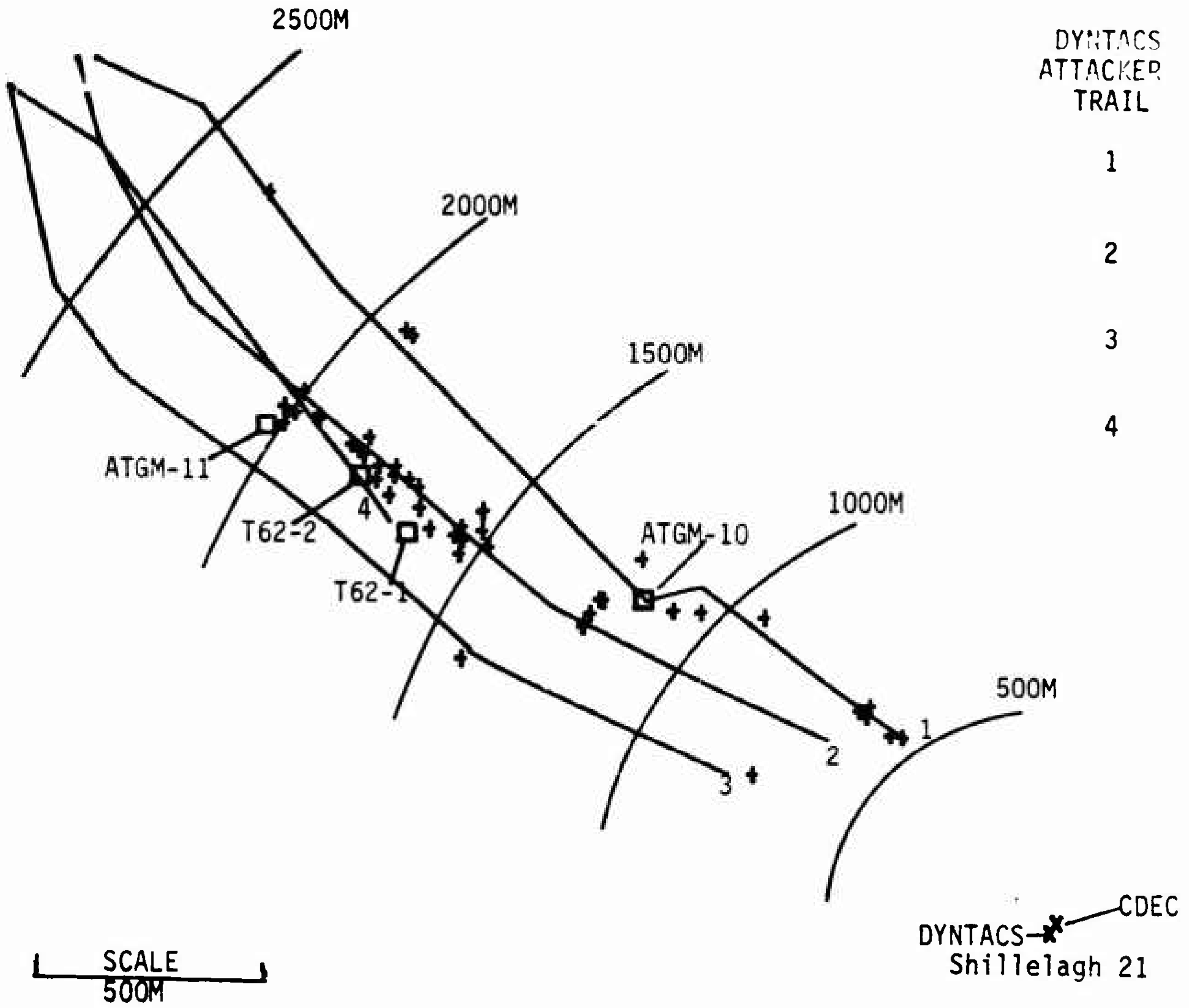


DYNTACS ATTACKER TRAIL	ASSIGNED WEAPON	
1	ATGM - 10 T62 - 7	ICV - 14 T62 - 3
2	ATGM - 11 T62 - 2	ICV - 15 T62 - 8
3	ATGM - 12 T62 - 9	ICV - 13 T62 - 5
4	T62 - 1	

+ = DYNTACS TOW 19 impact points

□ = CDEC TOW 19 impact points

Figure 3-7. DYNTACS Trial 96 Base Case - Impact Points of TOW 19 Rounds



DYNTACS ATTACKER TRAIL	ASSIGNED WEAPONS	
1	ATGM - 10 T62 - 7	ICV - 14 T62 - 3
2	ATGM - 11 T62 - 2	ICV - 15 T62 - 8
3	ATGM - 12 T62 - 9	ICV - 13 T62 - 5
4	T62 - 1	

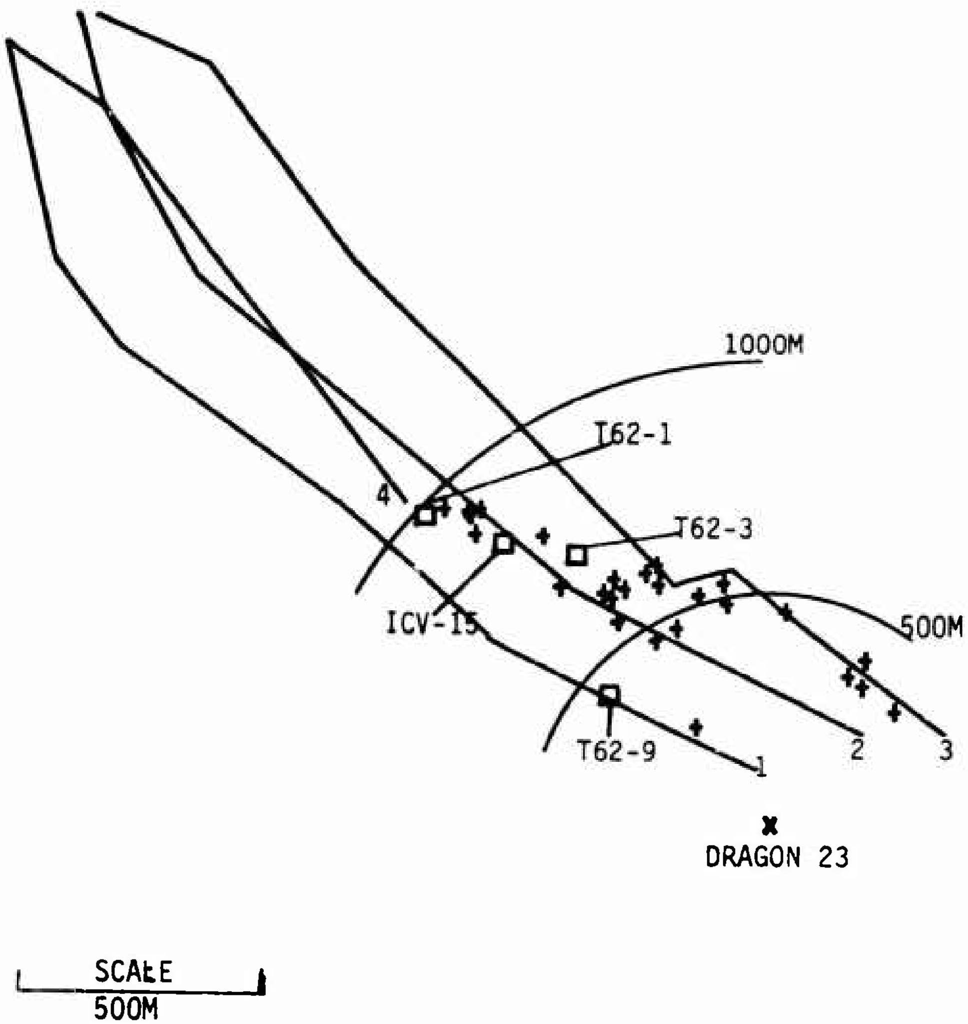
+ = DYNTACS Shillelagh 21 impact points

□ = CDEC Shillelagh 21 impact points

Figure 3-8. DYNTACS Trial 96 Base Case - Impact Points of Shillelagh 21 Rounds situation), timing is different. The major difference was inability of the Shillelagh to find and engage the center tanks as rapidly as in the field. Review of the model runs indicates that the model weapon had only intermittent intervisibility to the tanks at the time the field weapon was engaging tanks. This result may be due to the fact that, in the model, these tanks took up firing positions to engage TOW 19 and to achieve partial cover. At any rate the model Shillelagh took on the tanks too late to help the TOW.

(d) DRAGONs. In the field, DRAGON 24 was killed without firing a shot. The activity of DRAGON 23 was sporadic. It opened fire at the center platoon, firing one round at an ICV (the only shot at an ICV in the field) and one round at a previously killed tank. Three minutes later it had killed DRAGON 24. After another 3 minutes, when the attacker's right platoon apparently established intervisibility, DRAGON 23 fired one round (at 426 meters) and was killed by return fire. Considering this activity, DRAGON 23 apparently had opportunity to engage the center platoon at almost 1,000 meters on in, could have fired across the axis to the attacker's left platoon at a range of 800 to 700 meters, and could have engaged the right platoon as LOS became established at about 400+ meters. In the model, both DRAGONs were active to about the same level, and their combined level of activity is comparable to that of the single active DRAGON in the field. Figures 3-9 and 3-10 show impact points for firings by model DRAGONs 23 and 24. The model DRAGONs engaged the attacker center and left platoons. Engagements generally were at a shorter range (by 100 to 200 meters) than those of the field although an occasional shot was fired at the ranges noted in the field. This result indicates that intervisibility in the model was highly intermittent, allowing a few chance detections and shots at the engagement ranges seen in the field, but that intervisibility opened up about 200 meters further along the attack axis.

(e) Threat ATGM. The center ATGM in the field suffered an early mobility kill and was inactive thereafter. The left and right ATGMs each fired five rounds at the Shillelagh. Once the Shillelagh was killed the left ATGM, which had sustained a mobility kill, probably could find no more targets and was inactive. The right ATGM was also inactive for the final 6 minutes of the trial, after killing the Shillelagh. In the model the overall level of ATGM activity was similar, with an average of two engagements by the ATGMs per trial. The average number of ATGM firings per model trial was only 4.7, considerably lower than the 10 rounds fired in the field; however, the sequence noted in the field of 10 rounds to kill a single target would rarely occur. In the model the left and center ATGMs generally were active while the right ATGM engaged (and killed) the Shillelagh in only one replication. When it survived long enough to engage and fire (6 of 10 replications), the center ATGM engaged TOW 19 or the Shillelagh. This weapon engaged and killed the TOW on four replications. It also engaged the Shillelagh in three replications but never scored a kill. The ATGM in the left platoon was the most active, engaging the Shillelagh in half of the replications and engaging one or both of the DRAGONs in half of the replications.

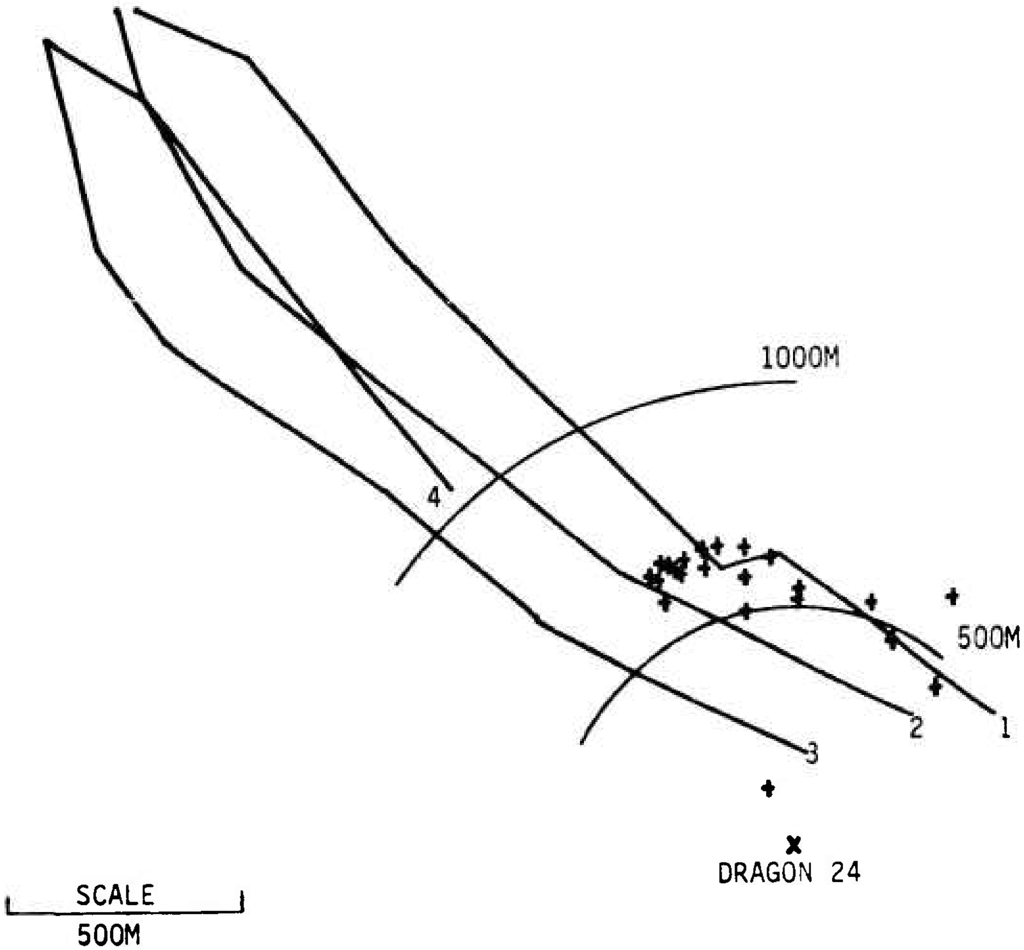


DYNTACS ATTACKER TRAIL	ASSIGNED WEAPON	
1	ATGM - 10 T62 - 7	ICV - 14 T62 - 3
2	ATGM - 11 T62 - 2	ICV - 15 T62 - 8
3	ATGM - 12 T62 - 9	ICV - 13 T62 - 5
4	T62 - 1	

+ = DYNTACS DRAGON 23 impact points

□ = CDEC DRAGON 23 impact points

Figure 3-9. DYNTACS Trial 96 Base Case - Impact Points of DRAGON 23 Rounds



DYNTACS ATTACKER TRAIL	ASSIGNED WEAPON	
1	ATGM - 10 T62 - 7	ICV - 14 T62 - 3
2	ATGM - 11 T62 - 2	ICV - 15 T62 - 8
3	ATGM - 12 T62 - 9	ICV - 13 T62 - 5
4	T62 - 1	

+ = DYNTACS DRAGON 24 impact points

□ = CDEC DRAGON 24 impact points

Figure 3-10. DYNTACS Trial 96 Base Case - Impact Points of DRAGON 24 Rounds

(f) Threat tanks. With the exception of one early shot at the Shillelagh, paired tank firings in the field were limited to seven rounds fired by two tanks, each of which killed a DRAGON. Additionally, there were 21 unpaired firings by five of the tanks. The large number of unpaired firings clouds any comparisons. (This level of unpaired firings was by no means exceptional in Experiment 11.8.) Every tank in the threat force, except the one killed with the initial round of the battle, fired at least once in the field but their targets cannot, in general, be determined. In the model one or more of the center platoon's tanks generally returned fire in response to the opening rounds fired by TOW 19. One or more tanks also engaged the Shillelagh on 8 of 10 replications. These tanks were usually from the left or center platoons although, in one instance, a tank on the attacker's right engaged the Shillelagh. In each of the replications, one or both of the DRAGONs was also engaged by tanks. Typically the DRAGONs were engaged by two weapons, one a tank or the ATGM from the attacker's left platoon and the other a tank from any of the three platoons. At any rate, the model results contain a mean of 4.7 engagements by tanks, and three engagements by tanks were noted in the field. The difference appears due to the model engagements of TOW 19, which was never engaged in the field.

(4) Discussion. The major difference between the model and field results for Trial 96 is the consistent ability of the attacker's center platoon to return opening fires quickly and to kill TOW 19. Thus, the model TOW was not available for the final shots observed in the field, and the pair of tanks killed with these final shots survived in the model. Secondary differences are the model firings at ICVs, which were ignored in the field; the relative ineffectiveness of the model Shillelagh in the opening portion of the battle; and the limited activity of TOW 18 in the model where TOW 18 was inactive in the field.

(a) The loss of TOW 19 in the model is probably due to the model detection algorithm. This algorithm credits detection of a firing weapon to all opposing weapons that have intervisibility with the firer. The detailed model output shows that upon firing one or two rounds, the TOW was detected by every vehicle in the attacker's center platoon and that all detections were made through this "firing cue" process. Given this detection and the absence of other detected defender weapons, the TOW was immediately engaged by one or more of the attackers. However, the TOW was never engaged in the field, and there is no clear evidence that it was ever detected. Given the alternative that the TOW may have been detected in the field, it is possible that the attackers could not react as rapidly and as well as in the model. This condition could explain the two unpaired firings by center platoon tanks in the field as poor shots in the general direction of the TOW.

(b) Firings at ICVs, particularly by the Shillelagh in the opening phase of the battle, may have degraded the defender weapon's ability to detect and engage more lucrative targets. This situation would be a problem of poor model input rather than a problem with the model itself.

(c) In addition to its tendency to detect and engage the ICV, the Shillelagh tended to lose intervisibility with the center platoon tanks at about the time they began to engage the TOW. This result accounts for its inability to take the pressure off the TOW in the opening phase of the battle. This critical blank space, in which the tanks tended to halt while engaging the TOW, might have been available in the field had the tanks engaged the TOW or, equally plausible, could be a problem with the model's intervisibility representation.

(d) The limited activity of TOW 18 in the model, as contrasted to total inactivity in the field, may be explained by excessive model intervisibility or by a deterioration of player interest in the field.

(5) Preliminary conclusions. There is a strong indication that the model exaggerates the ability of attacking weapons to detect targets based on firing cues and the ability of attacking weapons to bring effective return fire on a target rapidly. There is also an indication of potential intervisibility problems with the Shillelagh and TOW 18. The intervisibility problems are not clear, however; and the observed conditions could well have existed in the field. The model engagements of ICVs, which were ignored in the field, are also notable. Otherwise, there is no clear evidence of inconsistencies between field and model results.

c. Modified Case.

(1) Basis of change. The apparent high model rate of detections based on firing cues led to modification of the DYNTACS detection logic to allow an input probability of detection based on firing cues. With this change, when a weapon fires, each opposing weapon that has intervisibility to the firer may detect the firer. Whether an individual weapon does detect the firer, however, is based on comparing a random draw from a uniform distribution to an input probability of detection value. The original DYNTACS algorithm could be viewed as logically equivalent to this approach with the probability of detection fixed at unity. For the Trial 96 runs made under this modification, the probability of detection based on firing cues was set at 0.20.

(2) Battle outcomes. Results of the modified DYNTACS replications and the field trial are shown in table 3-10. The differences with the field noted in the base case remain to some degree. One TOW was generally lost in the model while both survived in the field. ICVs generally were lost in the model while they were ignored in the field. More threat tanks survived in the model, although the loss of six or all seven tanks now appears as a distinct possibility, showing up on three of the replications. Generally, the modification made the attacking force more vulnerable and moved the overall set of model results more in line with the field.

Table 3-10. DYNTACS Trial 96 Modified Outcomes

DYNTACS Replication Number	Number of Red Weapons Surviving (T62 - ATGM - ICV) (Initial strength 7 3 3)									Nr Blue Wpn Surv (TOW - Shill - DGN) Initial Strength		
	Force Stopped			Some Power at Objective			Much Power at Objective			2	1	2
1		-			-		4	1	1	1	0	0
2		-		1	0	0		-		1	0	1
3		-		2	1	1		-		1	0	1
4	0	0	0		-			-		1	1	2
5		-			-		3	2	2	1	0	0
6		-		2	0	3		-		1	0	0
7		-			-		4	1	1	1	0	0
8	0	0	0		-			-		2	1	0
9		-			-		4	2	3	1	0	0
10		-		2	1	2		-		1	0	0
Exp 11.8		-		1	1	3		-		2	0	0

(3) Weapon activity. Weapon activity summaries are presented in tables 3-11 and 3-12. The model modification was made to limit the detection process by which attackers in the model detected TOW 19. Thus, some increase in the survivability of TOW 19 and a resulting increase in activity for this weapon should be expected. The increased survivability should also extend to the other weapons, and some increase in their activity was also expected.

(a) TOW 18. As was noted for the base case, the model TOW 18 fired at the attacker's left platoon in an intervisibility window at 2,200 to 2,400 meters or as attackers reached the objective. The model modifications should have had no effect on this weapon since it was rarely detected even in the base case. Thus, the increase in this weapon's activity must be ascribed to randomness in its detection process.

(b) TOW 19. The modification reduced the volume of return fire received by TOW 19. This reduction was sufficient, in 4 of the 10 replications, to extend TOW 19's survivability to a period of over 5 minutes from the opening round. When TOW 19 did survive, it tended to engage or be engaged by the attacker's right platoon when that platoon was in the same position where it was fired upon by TOW 19 in the field experiment. It also fired at or was fired upon by the attacker's left platoon, with about equal likelihood.

(c) Shillelagh. The Shillelagh's activity level actually dropped with the modification. The data indicate that, while the average number of engagements by TOW 19 increased from 1.8 to 2.8, average number of engagements by the Shillelagh dropped from 4.6 to 3.6. This result could have occurred because the TOW took away targets from the Shillelagh. The detailed data, however, do not support this implication. The Shillelagh was no less active on replications when the TOW survived longer and, in fact, was relatively more active than when the TOW suffered an early kill. The reduction in Shillelagh activity may be a reflection of the randomness involved in the model.

(d) DRAGONs. Combined activity of the pair of DRAGONs increases from a mean of 3.8 engagements in the base case to 5.5 engagements with the model modification. This result is almost totally explained by DRAGON engagements of the attacker's right platoon, which were relatively infrequent in the base case. This result, in turn, is due to increased survivability of the DRAGONs, which in the base case generally were killed before intervisibility with the right platoon was established.

(e) Threat ATGM. The modification had no marked effect on the overall activity level of the threat ATGM, viewed as a group. Detailed comparisons show no distinctive patterns, with the activity of a given ATGM depending on how long it survives once intervisibility is established with the defenders.

Table 3-11. DYNTACS Trial 96 Modified - Defender Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		T62	ATGM	ICV	Total*	T62	ATGM	ICV	Total	T62	ATGM	ICV	Total
TOW 18	DYNTACS												
	Mean	1.2	0.2	0.4	1.8	0.9	0.2	0.3	1.4	0.6	0.2	0.2	1.0
	Std Dev	0.9	0.4	0.9	1.4	0.5	0.4	0.6	1.0	0.7	0.4	0.4	1.0
	Exp 11.8	0	0	0	0	0	0	0	0	0	0	0	0
TOW 19	DYNTACS												
	Mean	2.7	1.3	0.3	4.3	1.8	0.7	0.3	2.8	1.6	0.4	0.3	2.3
	Std Dev	2.2	1.3	0.6	2.2	1.5	0.6	0.6	1.8	1.5	0.5	0.6	2.1
	Exp 11.8	5	0	0	5	4	0	0	4	4	0	0	4
Shillelagh 21	DYNTACS												
	Mean	2.1	2.0	1.3	5.4	1.6	1.0	1.0	3.6	0.8	0.8	0.8	2.4
	Std Dev	1.0	1.7	0.9	2.3	0.8	0.6	0.6	1.4	0.7	0.6	0.6	0.9
	Exp 11.8	2	3	0	5	2	2	0	4	1	2	0	3
DRAGON 23	DYNTACS												
	Mean	2.0	0.8	0.7	3.5	1.5	0.4	0.7	2.6	0.6	0.4	0.3	1.3
	Std Dev	1.2	1.1	0.8	2.2	0.9	0.5	0.8	1.4	0.7	0.5	0.6	1.2
	Exp 11.8	3	0	1	4	3	0	1	4	1	0	0	1
DRAGON 24	DYNTACS												
	Mean	2.9	1.3	0.7	4.9	1.6	0.7	0.6	2.9	1.2	0.4	0.1	1.7
	Std Dev	1.0	1.3	0.6	1.8	1.6	0.6	0.4	1.0	0.9	0.7	0.3	1.0
	Exp 11.8	0	0	0	0	0	0	0	0	0	0	0	0
Total	DYNTACS												
	Mean	10.9	5.6	3.4	19.9	7.4	3.0	2.9	13.3	4.8	2.2	1.7	8.7
	Std Dev	2.6	1.6	1.5	4.7	1.5	0.4	1.4	2.5	1.5	0.8	1.2	3.1
	Exp 11.8	10	3	1	14	9	2	1	12	6	2	0	8

* Includes unpaired firings

Table 3-12. DYNTACS Trial 96 Modified - Attacker Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		TOW	Shill	DGN	Total*	TOW	Shill	DGN	Total	TOW	Shill	DGN	Total
T62	DYNTACS												
	Mean	1.9	1.8	3.3	7.0	0.9	0.5	1.7	3.1	0.4	0.4	1.0	1.8
	Std Dev	2.4	2.6	3.1	4.2	0.9	0.7	1.1	1.5	0.5	0.5	0.9	1.3
	Exp 11.8	0	1	7	29	0	1	2	3	0	0	2	2
ATGM	DYNTACS												
	Mean	0.7	1.4	2.9	5.0	0.6	0.6	0.9	2.1	0.5	0.4	0.5	1.4
	Std Dev	0.6	1.7	3.8	4.4	0.4	0.4	1.3	1.2	0.5	0.5	0.8	1.0
	Exp 11.8	0	10	0	10	0	2	0	2	0	1	0	1
Total	DYNTACS												
	Mean	2.6	3.2	6.2	12.0	1.5	1.1	2.6	5.2	0.9	0.8	1.5	3.2
	Std Dev	2.3	2.4	3.1	3.2	0.9	0.5	1.2	0.7	0.3	0.4	0.7	1.0
	Exp 11.8	0	11	7	39	0	3	2	5	0	1	2	3

* Includes unpaired firings

(f) Threat tanks. The threat tank activity level with the model modification decreased to a mean of 3.1 engagements per trial from the 4.7 engagements per trial in the base case replications. The decrease is spread over all defender weapon types.

(4) Preliminary conclusions. By decreasing detections, the modification had its desired effect of decreasing the level of rapid return fire by threat vehicles and thus extending survival of the defender weapons. This effect in turn enhanced the defender's ability to engage and moved the general model outcome into agreement with the field results. The possibility remains that the model gives individual attackers an exaggerated ability to react rapidly upon detection of a defender.

3-4. SUMMARY.

a. The following observations can be made on the basis of the detailed comparisons of DYNTACS results with the field experiment data for Trials 34 and 96.

(1) The overall battle outcomes noted in the field are consistent with model results in that the field outcome could be considered a sample of the set of results spanned by the DYNTACS replications.

(2) The DYNTACS algorithm that gives immediate "firing cue" detections to all intervisible observers exaggerates the detectability of firing weapons.

(3) The ability of attacking weapons to place effective return fire rapidly on defenders is exaggerated in DYNTACS. The exaggeration is beyond that which might be associated with the over-detection of firing cues noted above.

(4) There is no solid evidence that potentially poor intervisibility representation within the model caused serious discrepancies with field results. Questionable intervisibility regions, however, were identified.

(5) The unpaired firings that occurred in the field do not have any parallel in the model. General levels of activity noted in the model are in agreement with activity levels noted for paired firings in the field. There are, however, instances where individual unpaired firings in the field appear to be reflected by model firings. These are logically contradictory interpretations of the unpaired firings, and a satisfactorily objective general treatment of unpaired firings has not been found.

b. A critical limitation of these detailed comparisons, which seriously restricts their utility, is the lack of a field estimate of the variability of outcomes. Although the individual field trial results may be considered consistent within the spread of model results produced by 10 replications, there is no check on this spread itself. This limitation leaves unresolved a question that may be the most important part of the issue of model validity; i.e., how well the model reflects the variability of results to be expected from the field.

CHAPTER 4

ADDITIONAL DYNTACS OBSERVATIONS

4-1. INTRODUCTION. The detailed comparisons of DYNTACS results to the outcome of two Experiment 11.8 trails, reported in chapter 3, are limited to a small sample of the Experiment 11.8 data and to a constrained operation of the model. Additional information, potentially of a greater value in determining the reasonableness of the model, became evident in the course of reviewing the field experiment trials and in reviewing and setting up the model. The purpose of this chapter is to summarize this information and discuss its probable implications on model validity.

4-2. FIELD EXPERIMENT TENDENCIES. Certain characteristic patterns recur in the field experiment data reviewed for the TETAM Model Verification Study. The causes of these tendencies are in most cases a matter of conjecture, but their existence highlights some areas in which the model may be lacking. These field tendencies are presented in appendix D. Selected tendencies that have obvious implications for the model verification problem are discussed below.

a. Unpairing Firings. An unpaired firing was recorded in the field experiment when a weapon was fired but the laser illuminator linked to that weapon failed to elicit a response by any of the sensors mounted on target vehicles. Several potential explanations are available, but the actual causes of unpaired firings in the field are not clear. Some number of unpaired firings may be due to mechanical problems (e.g., laser malfunction, poor laser alignment, sensor malfunction, other instrumentation problems). Many unpaired firings, however, may be attributed to real-world phenomena such as reconnaissance by fire, firing at false targets, or poorly aimed shots. Whatever the cause, well over half the firings by attackers in the field were unpaired firings. In the model every shot is fired at a real, detected target. Thus, to the extent that the unpaired firings of the field represent a real-world phenomenon, they are not portrayed by the model and the model is not capable of producing potentially half the firing activity of attacking weapons. This situation was illustrated in the detailed comparisons for Trail 96 (chapter 3) where the model activity for attacking weapons was at the same general level as the paired firings from the field, but the model attackers were about half as active as the field weapons when unpaired firings were considered. Unpaired firings were less prevalent for the defender weapons, representing about 7 percent of the total defender firings in the 25 trials reviewed and rarely exceeding 10 percent of the defender firings for any one trail. Thus, the lack of model consideration of such fires appears more critical for the attacker.

b. Command and Control Problems. In the field trails, the ability of the player leaders (platoon and company commanders) to control player actions broke down regularly. Indications of this are found in the fact that attacker formations broke down and maneuver frequently deteriorated into individual movements once fire was received. Additionally, target handoffs from platoon leaders generally were ignored by the defenders.

(1) Fire control. Compared to most other combat simulations, DYNTACS representation of fire control is relatively sophisticated. However, it does not portray target handoff explicitly. On the basis of Experiment 11.8 results, in which target handoff had no apparent effect on the battles, this does not appear to be a serious model shortcoming. Whether the lack of impact of target handoffs on battle results would be expected in real world battle situations is an open issue. Beyond inability to portray handoffs, the DYNTACS fire controller lacks the flexibility to portray techniques noted in the field experiment results. For example, it appears that defenders in the field frequently (apparently on the platoon leader's command) withheld their initial fires until a point at which several defender weapons could engage the attacking force simultaneously. This technique cannot be portrayed in DYNTACS, nor can DYNTACS portray the individual behavior frequently noted in the field data whereby weapon crews would "pick their shots," passing up opportunities to engage a target in apparent anticipation of a better shot at the same target as it entered a larger killing zone. Neither is there any mechanism in DYNTACS for treating ammunition as being more valuable as it becomes scarcer. The extent to which this field experiment behavior would occur in real combat is not known.

(2) Movement control. The DYNTACS movement controller does not depict the tendency of attack formations to break down and the tendency of individual attack weapons to initiate independent movement as was noted in the field. The field experiment behavior may not have been typical, and individuals accustomed to operating as a unit under the imposed tactics may have had better success in maintaining unit integrity. However, the rigidity with which DYNTACS maintains unit formations is extreme. The tendency for movements to be individually oriented rather than unit oriented is probably exaggerated in the field experiment, but it is reasonable to assume that the individual in the real world would make some adjustment to his position in a unit formation in light of his individual situation. Within DYNTACS, a simulated maneuver unit leader selects his route in consideration of his individual situation, and the movement of other elements is based on the desired formation and the route of the leader, subject to the constraints of impassable terrain. (Actually the model purports to consider the unit formation but, in fact, it does not do so in a meaningful sense.) Thus, the leader may select a covered route for himself while the other elements, because of the rigidity with which formations are adhered to, are forced into highly vulnerable routes of advance. The flaws in this logic are that the simulated leader does not give sufficient consideration to the situation of his entire unit and the remaining elements are allowed no discriminatory action based on their individual situations.

c. Individual Perception Errors. The target selection and engagement process in the field is subject to individual error. The most obvious player error that appears in the Experiment 11.8 field data is range estimation error, which is reflected by 41 out-of-range firings in the 25 trials reviewed. False targets, which probably led to many of the unpaired firings discussed previously, are another perception problem. Numerous firings at previously killed targets were also recorded in the field, although many of these may have been due to delays in a target's signaling that it had been killed and may be traced to the experimental procedure. At any rate, there is ample evidence that the players in the field were subject to errors of a perceptive nature. In DYNTACS, target-related perception is nearly perfect. Previously killed targets cannot be fired at (and are not even detected). There is no concept of a false target in the model. Knowledge of a detected target includes precise knowledge of the target range, perfect target identification, and knowledge of whether the potential target has fired recently, whether it has fired at the individual firer, and whether any other firers are engaging that target.

d. Summary. In summary, individual elements appear to "follow the rules" too well in DYNTACS. The geometric patterns of a maneuver formation are slavishly adhered to (to the detriment of individual weapon performance). False targets are never engaged because they never exist. Given the detection of a potential target, all information pertinent to engagement is known perfectly and acted upon consistently. The field experiment, on the other hand, indicates that individuals in the field have serious problems in all these areas.

4-3. MODEL OBSERVATIONS. Familiarity with the basic ground game portions of DYNTACS resulted from the process of establishing data for DYNTACS runs and reviewing output. During this process, several questionable areas in the basic model logic and assumptions were identified. The issues discussed below are not necessarily related to comparison of the model to the TETAM field experiment, but they are nevertheless serious issues relating to the reasonableness of the model.

a. Event Sequencing Logic. DYNTACS is an event-sequenced model, and the logical foundation of the simulation rests upon the definition and timing of discrete events for the individual elements portrayed.

(1) An event is defined as a commitment to action during which a combat element will not alter its activities regardless of the activities of other elements. In the basic DYNTACS ground game only four types of events are possible: an element moves, an element fires one round from a stationary position, an element fires one round while moving, or an element neither moves nor fires. An event starts at the time the element's previous event ended. Events other than firing events end after some standard movement time, which is a single input value. A 30-second movement time has been used in most previous applications of

the model and was used in the TETAM model verification work. A firing event ends at the time the round should impact at the target. With the use of a standard movement time increment the model could be considered hybrid; that is, event sequenced for firing events but otherwise time sequenced. The definition of an event as a commitment to action that will not alter is weakened with the introduction of the movement time cycling.

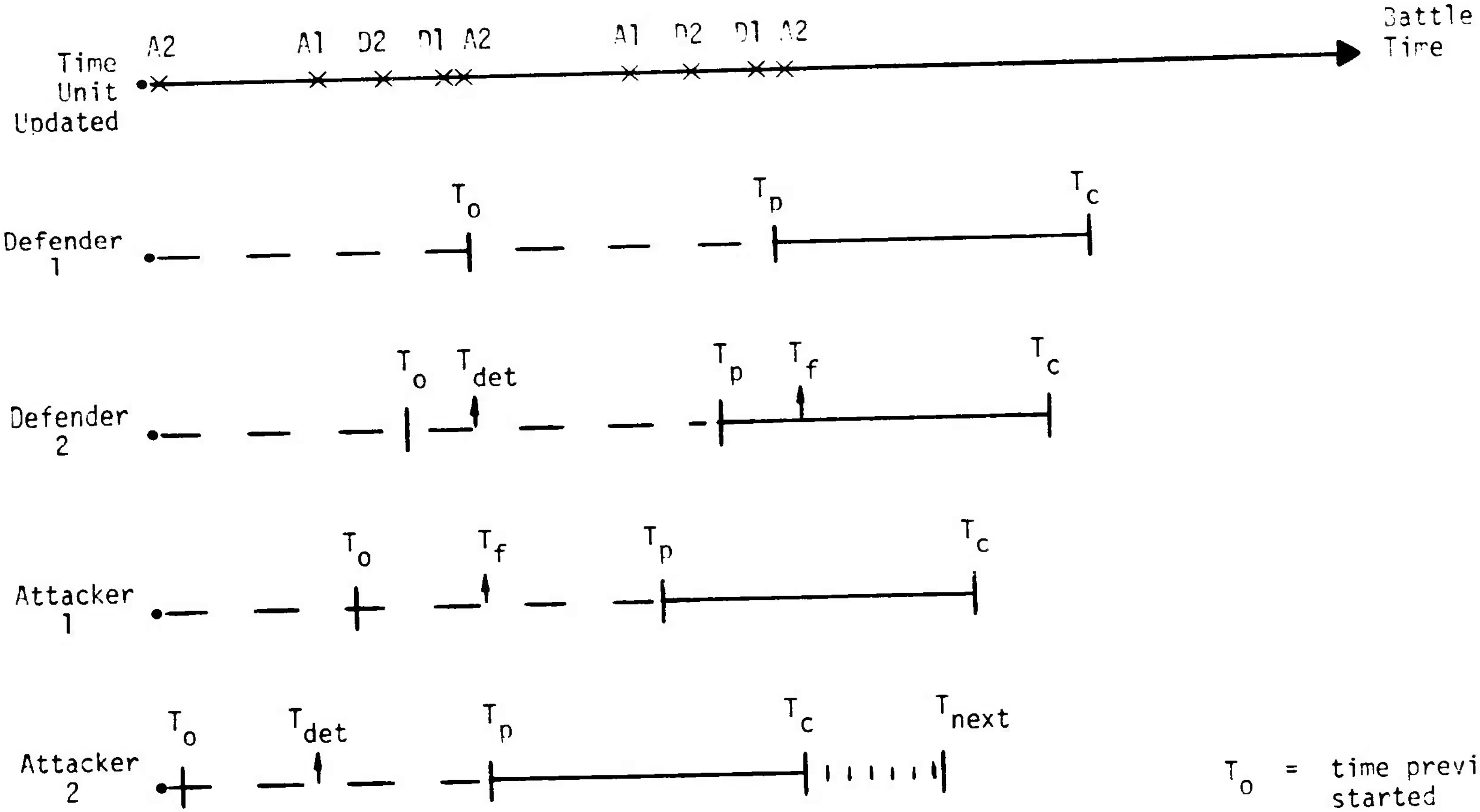
(2) Event sequencing in DYNTACS is accomplished by use of a set of element clocks set for the time that each element will complete its current event. Battle time, or the sequence of events, is stepped through by finding the element with the lowest clock time, processing that element's next event (which now becomes its current event), and setting the element's clock to the time at the end of the current event. The process is illustrated in figure 4-1 for two attack and two defense elements. Assume that the current event for Defender 1 has just been processed and this element's clock set to T_c, time the current event is scheduled to be completed. The clocks of each element will then be at the respective T_c times indicated, and element Attacker 2 will have the lowest clock and will be selected for the next update. In the time slice illustrated, the model has stepped through two events for each element as indicated on the overall battle time line. The processes represented for each event are, in the following sequence:

(a) The communication model transmits messages on the nets the current element is monitoring. This transmission may provide the element with general area intelligence of targets detected by other friendly elements.

(b) The intelligence status of the current element is updated. An element gains intelligence by the visual detection of enemy elements. Detections during the previous event are accounted for at the beginning of each event. An element may lose intelligence if intervisibility to previously detected targets is lost. Intervisibility is determined at the end of each event in which an element moves. For example, the intelligence for element Defender 1 of figure 4-1 was updated at that element's time T_p. This update included targets Defender 1 detected in the time span T_o to T_p (the previous event). The intervisibility status, however, with respect to target Attacker 1 and Attacker 2 used for this update was the status that existed at each element's T_c times (assuming they moved and Defender 1 was stationary).

(c) If the current element is a maneuver unit leader, it evaluates the current situation and may select a new route and formation for the maneuver unit.

(d) The current element reviews detected enemy elements and selects a target if appropriate.



T_o = time previous event started

T_p = time previous event ended/current event started

T_c = time current event scheduled to be completed

Figure 4-1. Example of event sequencing procedure used in DYNTACS

(e) Completion of the event depends on the outcome of the target selection process and on the current element's capability to fire while moving. Five cases exist:

1. If no target was selected and the element was not to move, the process is complete. The element's clock is advanced the standard movement time increment.

2. If no target was selected and the element is to move, a movement event for the standard increment takes place. Intervisibility status of this element with respect to all opposing elements is updated to reflect conditions at the end of the move.

3. If a target is selected and the element is in a stationary firing position, the target is fired upon and any terminal effects are accounted for. The element's clock is advanced to impact time of the firing.

4. If a target is selected, the element can move while firing, and it is not in a stationary position, the target is fired upon and any terminal effects are accounted for. Impact time is computed, and the element moves a distance based on this time. The element's clock is advanced to impact time, and intervisibility conditions are updated.

5. If a target is selected, the element was to move, but cannot move while firing, the element moves to a stationary firing position. Updates are as for a simple movement. The element will most likely fire at the target on its next event.

(3) The event sequencing logic described above leads to several logical inconsistencies and discontinuites in time. Some of the more obvious inconsistencies are discussed below.

(a) Intervisibility status is out of sequence with detections. Consider the case in figure 4-1 of element Defender 2 detecting element Attacker 1. At time T_p on the Defender 2 time line, this element detects for the period T_0 to T_p, the prior event time on its time line. This detection priod, however, is based on the current intervisibility status of each target. Suppose that Attacker 1 fired at time T_f shown on its time line and then, in its current event, moved. The Attacker 1 intervisibility status available to the model is that status that will be attained, after the move, at time T_c on the Attacker 1 time line. Given intervisibility at that time, Defender 2 will detect the firing cue, regardless of the intervisibility that existed at the firing position.

(b) Reaction to detections is delayed by some unpredictable amount of time. For the case of Defender 2 detecting Attacker 1, on the Defender 2 time line, at time T_p, the detection of Attacker 1 was determined to have taken place at time T_{det}. However, the Defender 2 reaction to this detection commences at time T_p. At this time the decision to fire is made, load and lay delay times are added to T_p to develop firing time T_f, and the round (missile) flight time is further added to determine impact time T_c. The net result is that an arbitrary delay, the period from T_{det} to T_p, was also assessed. Some delay time between detection and the decision to fire will be appropriate. The problem is not necessarily that a delay exists but rather that it is interjected in a spurious manner by the model logic rather than by any designed or controlled means.

(c) Terminal effects of firings are prematurely determined. In the case of Defender 2 attacking Attacker 1, terminal effects are determined, and the results recorded, at time T_p on the Defender 2 time line, although impact should not occur until time T_c. Consider now Attacker 2, which will become current at time T_c on its time line. Suppose, at this time, Attacker 2 fires at and kills (at time T_{next}) Defender 2. Then Defender 2 should be dead before its round impacts, but the effect of its round has already been determined and recorded. This result could easily occur if Defender 2 is firing an antitank missile with relatively low firing rates and slow flight times and Attacker 2 is firing tank rounds with relatively high firing rates and fast flight times. Further, if it is critical that the Defender 2 missile be guided to impact, a dead crew has been allowed to guide the round through the final portion of its flight. This situation took place in the TETAM trials; and in a review of the 20 DYNTACS replications for Trial 96 (discussed in chapter 3), 25 instances were found where a dead crew fired an antitank missile and guided it to impact.

b. Communications in DYNTACS. The DYNTACS communication model provides a means for individual elements to exchange general area target information. Beyond this provision, communications capabilities or limitations have no impact upon the basic ground model. Although fire control and movement control are represented within individual model modules, the implicit assumption is made that control means function perfectly. This assumption partially explains the inability of the model to portray the breakdown in maneuver control in the TETAM field experiment. This breakdown was attributed to restriction to a single communication net for the attackers, which restriction could have no effect on control within the model.

c. Intelligence in DYNTACS. The play of intelligence in DYNTACS centers upon the visual detection of enemy elements, which is one of the most difficult problems involved in model development.

(1) Approach in the model. At any instant, an individual element has one of four possible levels of knowledge with respect to each enemy element: no knowledge, general area knowledge, full knowledge, or pinpoint knowledge. At the beginning of each event the current element's level of

knowledge for each enemy, or intelligence status, is updated. Full or pinpoint knowledge is required to engage a target. General area knowledge is sufficient for any maneuver control decisions based on the threat. Any level of knowledge implies that the existence of the enemy element is known, that it is identified, and that whether it has been killed is known. Pinpoint knowledge was defined at the time of original model development as the situation where the element lays its weapon on a firing signature but has no clear view of the target (due to concealment). This definition appears to have been lost during evolutionary model changes. (See appendix B, Model Bibliography.) A pinpoint now is a transitory detection that will be lost if the target is not selected for engagement on the detecting element's current event. An element can have pinpoint knowledge of only one target at a given time.

(a) Loss of intelligence. Once an element gains knowledge of an individual enemy element, it can never possess less than general area knowledge of that enemy. Full or pinpoint knowledge is reduced to general area knowledge with loss of intervisibility. If the element is neutralized for the entire previous event or if it fired and was neutralized at the end of the previous event, all full or pinpoint knowledge is reduced to general area knowledge with the exception that knowledge of the target selected (if any) during the previous event becomes pinpoint knowledge. As mentioned above, pinpoint knowledge becomes general area knowledge if the enemy element is not selected as a target.

(b) Acquiring intelligence. An element's intelligence increases to general area knowledge when it receives an intelligence message about enemy elements for which it previously had no knowledge. When an element actually detects the enemy, knowledge becomes full or pinpoint. Detections may be accomplished by any of five procedures in the model.

1. Full knowledge is gained whenever a firing target is in view (not fully covered or concealed).

2. Pinpoint knowledge of a firing target may be gained (on the basis of a random draw) if the conditions outlined above are met but the target is fully concealed.

3. Full knowledge due to visual search may be gained (on the basis of a random draw) for each intervisibile and unconcealed target; however, this visual search is not conducted by a weapon during an event in which it fired.

4. Full knowledge is gained of each uncovered and unconcealed target in the search area through an "intensive area search" procedure. The search area is a rectangular region around a known target,

the dimensions of which are required input data. The intensive search procedure is carried out each time an element detects a target by one of the three procedures outlined above. It is also conducted, in the area of the target, every time an element fires.

5. Full knowledge of a previously pinpointed target is gained if the target becomes unconcealed. This event also keys an intensive area search. An intensive area search is also conducted about a pinpointed element if it was selected as a target but not fired upon.

(2) Critique. The intelligence model is poorly integrated into the event sequencing logic, as has been previously discussed. Considered as a separate entity, several other problems are obvious.

(a) The original visual search equations for detection rate were based on curve fitting of a body of empirical data. These data were limited in several critical areas. For example, maximum range was 1.57 kilometers, observers were stationary, responses were collected under what amounts to laboratory conditions, and a highly subjective terrain complexity factor was introduced to the resulting equation. A recent model addition provided a new equation for long ranges.

(b) Even with their limitations, the equations for detection rate may be the strongest part of the detection model. These equations are based on empirical data, but the remainder of the model appears to be a collection of questionable assumptions.

(c) Visual search is conducted such that the probability of looking in any direction can be described by a cardioid distribution, emphasizing search along a given axis of observation but allowing a balanced look about the full 360^{o} circle. This assumption may hold true for a rapidly moving element in open terrain in a meeting engagement environment. It is questionable for an element involved in a coordinated attack of a fortified position and for an element defending from a fortified position. It is patently wrong for the defenders in the TETAM experiment, who had their backs to a significant terrain feature and frequently were masked to the sides so that the area in which it was physically possible for them to see anything subtended a fan of well under 90^{o}.

(d) The TETAM field experiment indicates that the assumption that a firing weapon is immediately detected is false.

(e) With the exception of the visual search detection procedures, there is no discrimination between moving and stationary observers or targets. This condition allows such phenomena as the "pinpointing" of a moving target. Even where motion is considered, the adjustment for observer motion is arbitrary.

(f) The implicit assumptions of perfect identification and knowledge of whether a target has been killed, even if only general area knowledge is available, provide the fire control and movement control logic with more information than would necessarily be available in the real world. Additionally, full knowledge of the position, status, and activity of all friendly weapons seems to be assumed in the fire control and movement control logic.

(g) The general area knowledge does not deteriorate, regardless of how long it has been held or how far the target has moved since full knowledge was available.

(h) Definition of a "pinpoint" within the model has become obscure. Pinpoint knowledge can be obtained in the absence of any firing cues as a target transitions from the full to the pinpoint level by moving into an area of concealment.

(i) The visual search algorithm is bypassed for targets about which the observer has no knowledge, once a target has been detected in the current event. This device is used to account for the time spent in the intensive area search associated with each new detection. However, the detections based on firing cues or visual search for targets about which the observer has general area knowledge are not affected. Thus, as a battle progresses and the level of firing or general area knowledge builds up, the intensive area searches apparently cost an individual observer less and ultimately become free bonuses, with no accounting made for the time they might consume.

d. Movement in DYNTACS. Movement is portrayed within two modules of DYNTACS. The movement controller portrays maneuver control, including selection of unit routes, formations and speeds, and reaction to phase lines. The movement model portrays the actual movement of individual elements.

(1) Maneuver unit organization. Movement in DYNTACS is based on a maneuver unit concept. Within the model, a maneuver unit is a group of elements that moves as a coherent entity under the control of, and according to decisions made by, an individual maneuver unit lead element. The model user has flexibility in defining maneuver units and the associated task organizations in that an individual section, a platoon, or a team composed of several platoons can be designated by the model user as making up a maneuver unit. As discussed later, the maneuver control function represented in the model becomes increasingly more stereotyped and less reasonable as maneuver units are designated at higher levels of organization.

(2) The movement controller. The movement controller module of DYNTACS represents the decision-making process of each maneuver unit leader. Discussion in this review is limited to an attacking maneuver unit.

(a) General approach. Each time a maneuver unit lead element is the current element, an opportunity is given for several decisions. Should the maneuver unit react to, or terminate reaction to, a phase line by adjusting the unit's desired speed? Should the leader select a new route, formation, and desired speed based on a perceived change in threat? Should the leader reevaluate his current route, formation, and desired speed? Should the leader slow down to allow lagging elements to catch up? Each of these decisions is controlled by the model user through the input of such items as phase lines, desired speed at phase lines, critical factors defining how much change in perceived threat should cause the leader to reassess his situation, or how far an individual should be allowed to lag his desired position in the formation. The module is a relatively sophisticated set of algorithms and is probably sufficiently flexible that the user could effect a reasonable portrayal of the decision factors considered.

(b) Critique. The major criticism of the movement controller arises from a model assumption that the individual element has the information required for his decisions; he knows the threat situation too well. Once he has general area knowledge of an enemy element, he knows what the element is and its status (and its exact position if that knowledge is needed for a decision). He may underestimate the threat if only a limited number of the threat element have been detected, but he cannot overestimate. For example, if five friendlies detect the same enemy target, the leader knows that only one target has been detected. The maneuver unit leader also knows when he has reached a phase line and knows when any other maneuver unit has reached a phase line. He knows if any individual element is lagging and knows exactly how many friendlies in the entire force have been lost.

(3) Individual movement.

(a) General approach. Maneuver unit lead elements follow the route selected in the movement controller logic. Other elements guide on the leader. The route they follow is defined in terms of the leader's selected route and the geometric patterns of desired unit formations. Deviation from the selected route can occur only to avoid impassable terrain.

(b) Critique.

1. The strict geometric interpretation of tactical formations is unrealistic. Individual vehicles are not allowed to take advantage of local cover or concealment and can be forced into unreasonably vulnerable paths.

2. The module contains a highly detailed mobility algorithm. The level of detail in this algorithm and the associated data

input requirement are excessive. For example, the algorithm requires the coefficient of air resistance for a vehicle. The algorithm in itself may be sound, but it is out of balance with the rest of the model.

3. Local chokepoints; e.g., river fords, road embankments, are not portrayed. The mobility algorithm discussed above could handle these conditions easily, but there is no apparent way to incorporate them into the terrain, nor could the movement controller react to them.

4. The minefield logic, as coded in the model, is obscure. This logic is "shoehorned" into the movement logic and makes the logical flow of the entire movement and movement control areas difficult to decipher.

e. Weapon Firings in DYNTACS. Weapon firing is handled in three logical areas of DYNTACS representing fire control, discharge of weapons, and terminal effects of weapons. In the TETAM study, terminal effects algorithms used in the conduct of Experiment 11.8 were incorporated into the model, and the model algorithms have not been reviewed. Discharge of weapons is represented through load, lay, and projectile flight times and is straightforward (although event timing is questionable, as already discussed). Therefore, the following review deals only with the depiction of fire control.

(1) Approach. Representation of fire control in DYNTACS centers upon the selection of targets by individual weapons. This selection is accomplished, given a set of potential targets, by application of a set of range adjustment factors and selection of the target with the smallest adjusted range. The adjustment factors depend on target type, amount of cover, whether the observer has just fired at the target, whether another friendly element is firing at the target, whether the target has just fired, whether the target has just fired at the observer, and whether the target is in the observer's sector of responsibility. The fire controller also controls opening fire through a maximum allowable range for each ammunition and target combination. There is some attempt to portray transfer of targets between elements and fire and movement tactics. However, this portrayal is limited to allowing an element to seek new targets or to move, once it has fired some number of rounds (input) at a specific target, if another friendly element is engaging the original target.

(2) Critique.

(a) Setting target priorities by the use of range adjustment factors is cumbersome. It is also doubtful that the typical model user can provide a set of factors that will clearly indicate desired priorities.

(b) There is no opening engagement logic. Each side follows its pre-established rules regardless of which side fired the first round. It is impossible, for example, to hold fires until 1,000 meters unless the other side fires but to open fires at 2,000 meters if the other side fires. It is also impossible with two identical weapons in different positions to have the near weapon hold fire until both can open. The maximum range also could cause a weapon to withhold fire when it suffers a mobility kill where the weapon would, in fact, return fire.

(c) The model assumes that the round in the tube is always the optimal round for the target. It also assumes that only one subsystem can be fired at a time.

(d) It is doubtful that the transfer of targets portrayed in the model is any reasonable representation of what actually takes place when elements are advancing with fire and movement.

(e) An implicit assumption is made, similar to that noted in the movement controller, that the individual element knows everything about each detected target as well as which targets his compatriots are engaging.

(f) No mechanism exists for portraying reconnaissance by fire, firing at suspected target locations, or suppressive fire.

(g) There are no formation constraints on firing; for example, tanks in a column could all fire to the front.

4-4. SUMMARY. Review of general tendencies in the TETAM experiment and the DYNTACS logic identified numerous model shortcomings, the more critical of which are summarized below:

a. Event sequencing in DYNTACS is poorly implemented both in the definition of an event and in the time relationships within an event and among several events. When it is possible for a dead crew to guide a missile successfully, the definition of an event as a "commitment to action that will not be altered" has not been implemented. When a detection is said to occur at one time, based on conditions at a second time, and reaction to the detection takes place at a third time, the time relationships in the event sequencing have not been well established.

b. The total play of intelligence is questionable, not only in those areas of the intelligence submodel where acquisition is portrayed explicitly but also within those portions of the model, such as the movement and fire controller, where implicit assumptions as to the amount of knowledge available are made. Further, with the exception of the algorithms used to calculate visual detection rates, intelligence portrayal is apparently based entirely on a complex set of interrelated assumptions, only the more obvious of which have been identified in this review.

c. The communications model has no direct impact on anything but the intelligence model. In particular, it has no direct impact on command and control functions.

d. The representation of tactical formations is rigid and could force individual elements into portions of a battlefield that a real world element would avoid.

CHAPTER 5

DETAILED IUA COMPARISONS

5-1. INTRODUCTION.

a. This chapter contains the detailed comparisons of IUA and field experiment results for the situations established in CDEC Experiment 11.8 Trials 34 and 96. These trials are two of the better-controlled experiments for which data are available, and they represent the two modes of attacker tactics used in Experiment 11.8. During Trial 34 attackers executed a rapid approach tactic, and in Trial 96 they used a fire and movement tactic.

b. The IUA model consists of three segments. The terrain processor, which determines line-of-sight opportunities between a firer and potential targets; the mobility processor, which determines attacker movement toward static defensive positions; and the main battle model, which simulates the target acquisition, engagement, and attrition process. There are certain portions of the IUA model for which no comparison was made with field tests. These portions include the model's ability to simulate vehicle movement and assess casualties using the IUA vulnerability data base. As was noted in chapter 2, in these cases a special data base was developed from the field experimentation data, and the model was programed to accept and use the field data. The primary purpose of this comparison is to determine IUA's ability to produce a series of engagements that approximate the events of the CDEC field trials. The primary submodels of the main battle model examined were those that produce events representing battle conditions of tactical command and control, intervisibility, target acquisition, target prioritization, and firer/target response times.

c. An extensive analysis of the field trials indicated that none were replications of a similar defensive or threat tactic. Consequently, each field trial is viewed as a unique battle, and this battle is compared with a set of 10 model replications of the same tactical situation. The comparisons are oriented to exploring the following questions:

(1) Can the field outcome be viewed as a sample from the population represented by the set of model replications?

(2) Where differences between model and field results are noted, is there a logical explanation for the difference that leads to acceptance of the model outcome?

(3) Where differences between model and field results are noted, is there a logical explanation for the difference that points to a potential problem area in the model?

5-2. TRIAL 34 COMPARISONS.

a. Base Case In the following discussions, the initial comparisons between model and field results are referred to as the base case. Comparisons made subsequent to model or input modifications are referred to as excursions.

(1) Situation portrayed. During Trial 34, attackers executed a rapid approach tactic with an attacking force consisting of seven T62 tanks, two ATGMs, and two ICVs. The main objective was for the tank force to overrun the defensive area, with the ATGMs providing overwatch fire. The rigid tactical structure of IUA should make it well suited for simulating a battle of this type. The approach taken for model setup was to prepare the tactical data base in the same manner as one would normally proceed when running IUA for a study, with the field maneuvers of both defensive and offensive forces simulated using tactics currently available in the model. The IUA runs for Trial 34 were conducted using one primary axis of advance for the threat force. The model threat force structure consisted of three tank platoons with two T62 tanks in each platoon, a section of ATGMs containing two vehicles, a section of ICVs containing two vehicles, and a company commander in a seventh T62 tank. The primary difference between the model and field trials was the routes used by the attacking force. Rather than allowing each vehicle to follow an individual path, as in the field, the IUA model requires that individual attack routes be assigned to platoons containing two or more vehicles. All vehicles are required to follow the attacker path assigned to their platoon or section. Each of the tank platoons, the ATGM section, and the ICV section were assigned a route of advance. The tank commander was also assigned an attack route although model restrictions required that an extra vehicle be placed on the tank commander's route. This dummy vehicle could not fire, nor could it be fired upon by the defenders, and had no effect on the battle. Six to eight points representing attacker platoon movements were input to the model describing each attack route. The points for each route were obtained from the field trial analysis. The defensive force consisted of two TOWs, one Shillelagh, and one DRAGON. The model weapons occupied locations on model terrain corresponding to their respective field positions.

(2) Battle outcomes. The overall battle outcomes in terms of surviving weapons are shown in table 5-1. The IUA model discriminates among mobility, firepower, and total (mobility plus firepower) kills, but an attacking weapon is removed from further consideration as target or firer as a result of any of the three types of kill. Defender weapons are removed from the battle only after a firepower or a total kill. Consequently, the kill results presented for IUA include all types of kills

Table 5-1. IUA Trial 34 Base Case Outcomes

IUA Replication Number	Number of Red Weapons Surviving (T62 - ATGM - ICV) (Initial Strength 7 2 2)				Nr Blue Wpn Surv (TOW - Shill - DGN) Initial Strength 2 1 1
	Force Destroyed	Force Stopped	Some Power at Objective	Much Power at Objective	
1	-	0 2 0	-	-	1 1 1
2	0 0 0	-	-	-	1 1 1
3	-	0 1 0	-	-	1 1 0
4	-	0 2 0	-	-	2 1 1
5	-	0 2 0	-	-	2 1 1
6	-	0 1 0	-	-	2 1 1
7	-	0 2 0	-	-	1 0 0
8	-	0 2 0	-	-	2 1 0
9	-	0 2 0	-	-	2 1 1
10	-	0 2 0	-	-	2 1 1
Exp 11.8	-	-	2 2 2	-	2 0 1

against the attacker and firepower and total kills against the defender. Table 5-1 is a clear indication that the attack force is overkilled in IUA. All tanks and both ICVs were lost in every model replication. Survival of ICVs in the field may be a result of the players tending to ignore the unarmed ICV. The model could be made to ignore the ICV by proper target priority data. Even with the added distraction of the ICVs, the model defenders were able to destroy all tanks, while only five tanks were lost in the field trial. Comparability in terms of surviving Blue weapons appears to be acceptable.

(3) Weapon activity. A comparison of the battle activity for the model and field forces is shown in table 5-2. The mean and standard deviation from 10 IUA replications for the number of rounds fired, engagements, and kills by each defender element against a specific attacker weapon type are compared with the field results. The total number of rounds fired by the field force include unpaired firings. The number of engagements shown in the chart was determined by counting the number of times that a gunner fired one or more consecutive shots at the same target. All kills are included except mobility only kills to defenders.

(a) TOW 18. A comparison of TOW 18's performance in the model and the field is shown in the first line of table 5-2. The locations of the impact points for all paired field firings (indicated by □) and for all firings from the IUA replications (indicated by +) by TOW 18 are shown in figure 5-1. The IUA attacker trails and the weapons assigned to each trail are also shown in the figure. Those segments of the attacker trails that were visible to the IUA TOW 18 are shown by solid line segments. Those portions of the trail obscured by the terrain are shown by the dotted lines.

1. The TOW field crew engaged T62-4 and ICV-13 at ranges between 1,700 and 2,100 meters. The IUA TOW engaged targets in three areas of the battlefield. IUA firings at ranges of 1,300 to 2,000 meters appear to compare with field firings. The model also fired on those trails carrying T62s at ranges of 2,300 to 2,500 meters (area A) and again at 1,000 to 1,400 meters (area B). The explanation for firings in these areas lies in the inability of IUA to play local vegetation around defensive positions. Inspection of photographs of TOW 18's field position indicates that there are several large trees around the position limiting the TOW crew's view to only the rightmost routes used by the attackers during the field trials. The current version of the IUA line-of-sight processor assumes that no local vegetation exists around the defending position that will block his view of the terrain. Removal of these trees gave the IUA gunners a commanding view of the battlefield at 2,000 to 2,500 meters (area A) and again at 1,000 to 1,500 meters (area B).

Table 5-2. IUA Trial 34 Base Case (continued next page)

Defender Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		T62	ATGM	ICV	Total*	T62	ATGM	ICV	Total	T62	ATGM	ICV	Total
TOW 18	IUA												
	Mean	3.7	0.1	1.1	4.9	3.2	0.1	1.0	4.3	2.1	0.1	0.6	2.8
	Std Dev	0.9	0.3	0.7	0.8	0.9	0.3	0.6	0.9	0.9	0.3	0.7	1.0
	Exp 11.8	3	0	1	5	1	0	1	2	1	0	0	1
TOW 19	IUA												
	Mean	5.0	0.0	0.4	5.4	3.7	0.0	0.3	4.0	2.5	0.0	0.1	2.6
	Std Dev	1.8	0.0	0.7	1.6	1.6	0.0	0.4	1.4	0.8	0.0	0.3	0.9
	Exp 11.8	7	0	0	8	5	0	0	5	4	0	0	4
Shillelagh 20	IUA												
	Mean	3.8	0.4	1.4	5.6	3.3	0.4	1.4	5.1	2.2	0.4	1.3	3.9
	Std Dev	1.2	0.7	0.7	1.0	0.9	0.7	0.7	0.9	1.1	[illegible]	0.6	1.1
	Exp 11.8	4	0	0	4	2	0	0	2	0	0	0	0
DRAGON 24	IUA												
	Mean	0.6	0.0	0.0	0.6	0.4	0.0	0.0	0.4	0.2	0.0	0.0	0.2
	Std Dev	0.9	0.0	0.0	0.9	0.5	0.0	0.0	0.5	0.4	0.0	0.0	0.4
	Exp 11.8	4	0	0	4	2	0	0	2	0	0	0	0
Total	IUA												
	Mean	13.1	0.5	2.9	16.5	10.6	0.5	2.7	13.8	7.0	0.5	2.0	9.5
	Std Dev	3.1	0.7	0.8	3.0	2.6	0.7	0.6	2.7	0.5	0.9	0.0	0.7
	Exp 11.8	18	0	1	21	10	0	1	11	5	0	0	5

* Includes unpaired firings

Table 5-2. IUA Trial 34 Base Case (concluded)

Attacker Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		TOW	Shill	DGM	Total*	TOW	Shill	DGM	Total	TOW	Shill	DGM	Total
T62	IUA												
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Std Dev	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Exp 11.8	0	0	0	2	0	0	0	0	0	0	0	0
ATGM	IUA												
	Mean	0.9	0.7	1.8	3.4	0.9	0.6	0.5	2.0	0.4	0.1	0.3	0.8
	Std Dev	0.8	1.3	2.4	3.8	0.8	1.0	0.7	2.1	0.5	0.3	0.4	1.8
	Exp 11.8	0	3	2	8	0	1	2	3	0	1	0	1
Total	IUA												
	Mean	0.9	0.7	1.8	3.4	0.9	0.6	0.5	2.0	0.4	0.1	0.3	0.8
	Std Dev	0.8	1.3	2.4	3.8	0.8	1.0	0.7	2.1	0.5	0.3	0.4	1.8
	Exp 11.8	0	3	2	10	0	1	2	3	0	1	0	1

* Includes unpaired firings

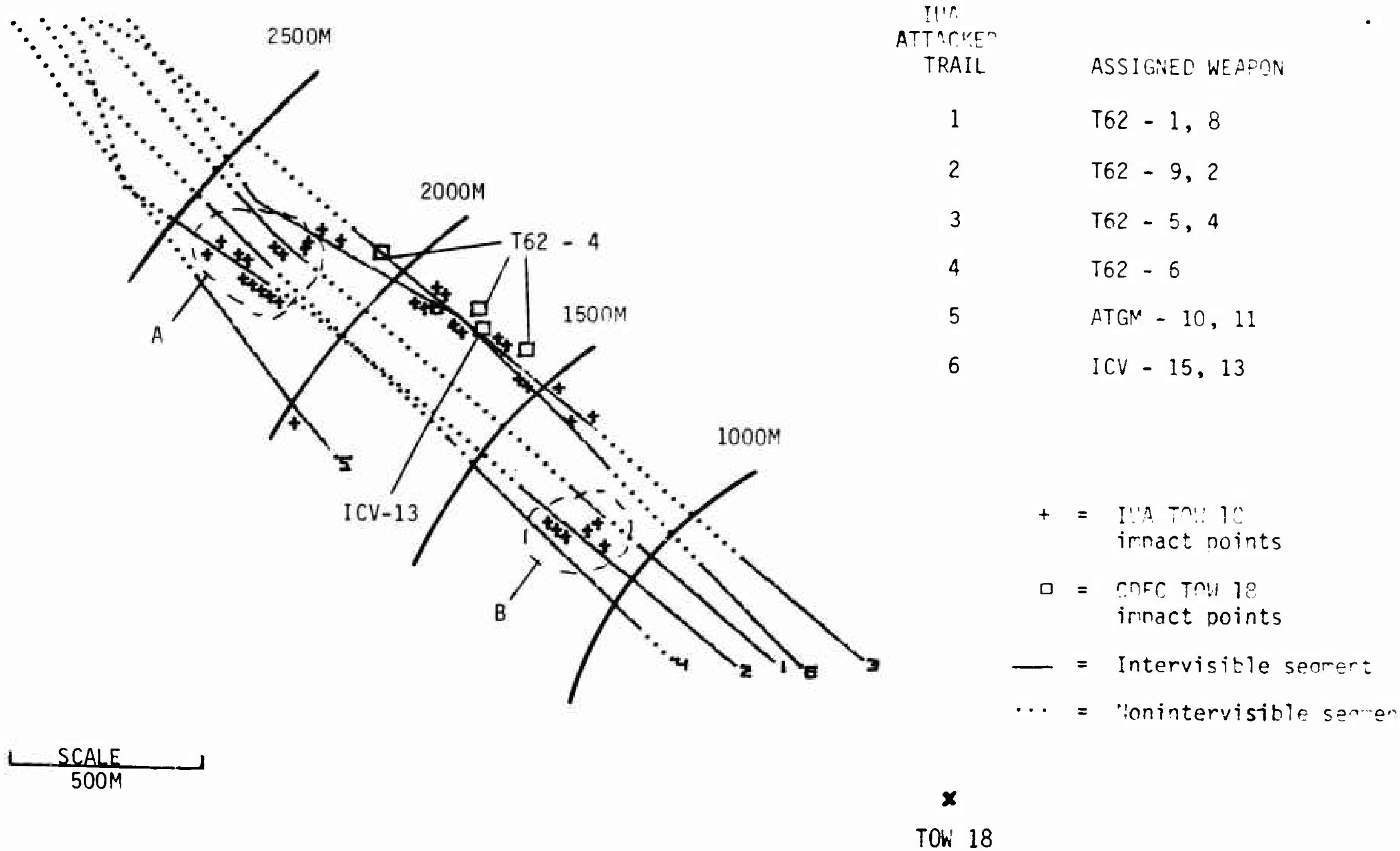


Figure 5-1. IUA Trial 34 Base Case - Impact Points of TOW 18 Rounds

2. Firings at the ATGMs on trail 5 by model gunners is also shown in figure 5-1. Field crews apparently had line of sight with these positions and were unable to detect and fire at two targets in this area because the targets were hidden in a tree line. The ATGMs had no flash-band simulators during this trial and provided no firing cues to the field defenders.

3. The excessive intervisibility for the model TOW is reflected in an increased number of engagements and kills (table 5-2), more than double the number occurring in the field. One other anomaly is noted in figure 5-1. Two model firings impacted on trail 2 (area A) at a range of 2,300 meters in a segment of the trail that was masked from the IUA gunner's view. These points represent firings that were initiated while the target was in the visible segment but loss of line of sight occurred before impact. No casualties are assessed against the target under these conditions.

(b) TOW 19. The number of shots, engagements, and kills for TOW 19 can be seen for both the field and model in table 5-2. Figure 5-2 shows the impact locations of shots fired by TOW 19 during 10 replications of IUA and during the field experiment. Intervisibility for IUA's TOW 19 with trails 1, 2, 4, and 6 begins at approximately 1,800 meters, and the model simulates these field firings well at ranges of 1,400 to 1,750 meters and at 500 and 750 meters. Shots against the ATGMs are noticeably absent from both the field and the model runs. In both the field and the model, terrain prevented intervisibility between the ATGM position and TOW 19. Two primary areas of disagreement exist between the model and field firings. These areas are enclosed by dashed lines.

1. The first region (A) shows the IUA gunner firing several shots against attackers on trails 1, 2, and 4 at a range of 1,000 to 1,300 meters. The only shot close to this area in the field was engagement of tank T62-9 at a range of 870 meters. Tanks 8 and 9 moved through this area during the field trial. There are two possible explanations for the absence of field firings in this area. TOW 19 had just completed an engagement of tank 8,and tank 9 may have been allowed to move through the area undetected while the field crew concentrated on tank 8 for verification of a kill. IUA defensive players have immediate knowledge of round impact effects and shift immediately to another target after achieving a kill. The second explanation is that the field crew did not have intervisibility with this area of terrain. It is obvious that the model did not play intervisibility correctly on trail 4 at 750 meters since a field shot against tank 9 occurred in a area that was not visible to the IUA TOW gunner.

2. The second area of concern (B) shows the IUA TOW firing at tanks 4 and 5 on trail 3 at a range of 700 to 800 meters. The route represents an extrapolation of tank 4's movement since there were

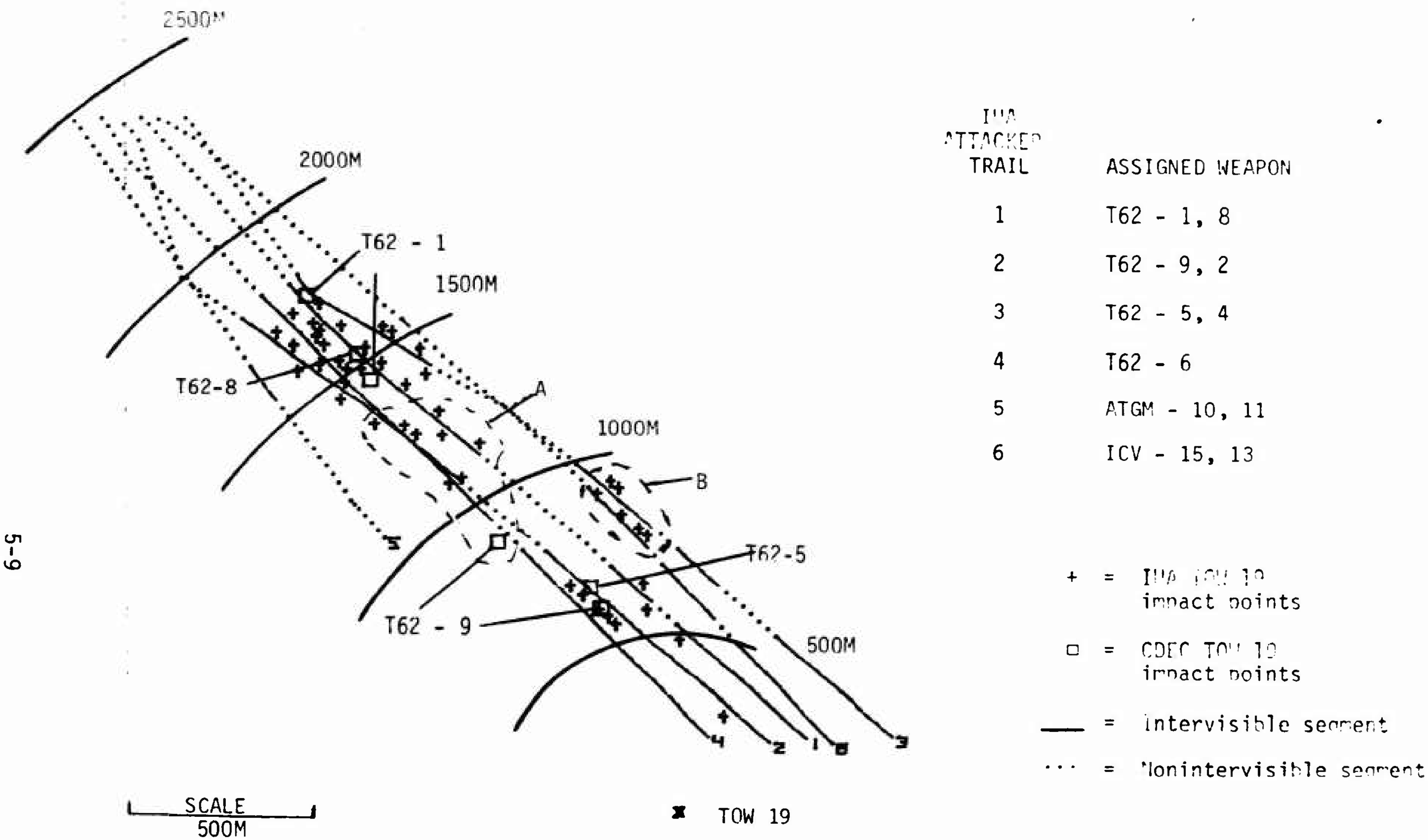


Figure 5-2. IUA Trial 34 Base Case - Impact Points of TOW 19 Rounds

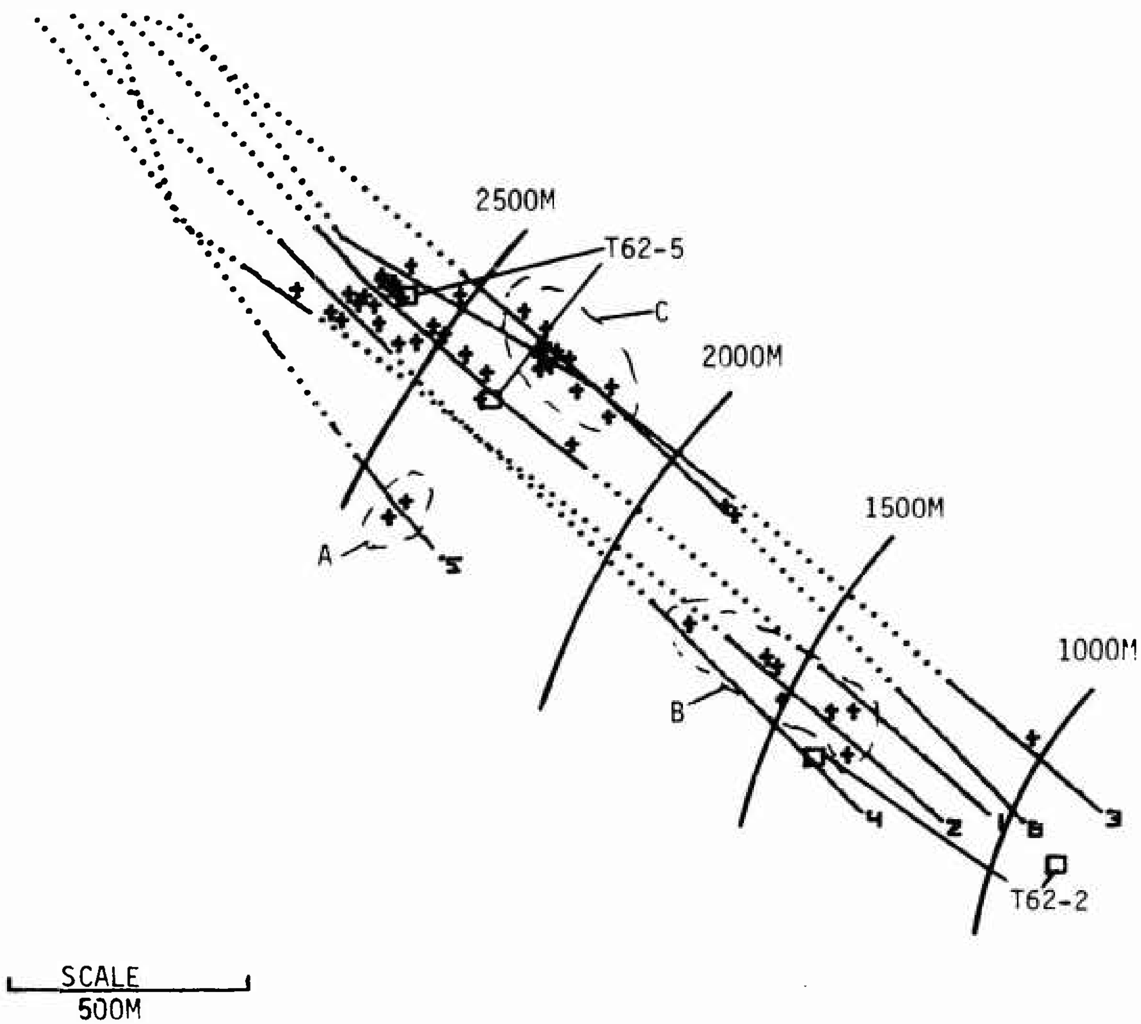
no live tanks in this area in the field trial. An analysis of the field positions indicates that the field TOW 19 had intervisibility with this area and could have engaged live targets if they had been present. The model TOW 19 activity level is lower than in the field. This result is due to the exaggerated activity of TOW 18 and a resulting limited number of targets available to TOW 19.

(c) Shillelagh. A summary of Shillelagh firings, engagements, and kills for the field and the IUA base case is shown in table 5-2; and impact points for the Shillelagh field firings and 10 IUA replications are shown in figure 5-3.

1. Both the model and field Shillelagh fire into the same area at a range of 2,250 to 2,800 meters. The field Shillelagh crew completed two shots against tank 5 in this area. These two shots point out a situation that occurred several times during Trial 34; i.e., the tendency of field crews to respond very slowly when re-engaging the same target. The CDEC firing records indicate that the time between the first and second firing was 49 seconds. If a 15 to 20 second period is allowed for first round flight, 29 to 34 seconds are left between first round impact and firing of a subsequent round. It is probable that this time was spent by field firers searching for damage assessment cues. IUA does not include any time for target damage assessment by a firer. Shots are fired in the model after a 10 to 15 second pause for reload. Consequently, subsequent shots by IUA at the same target occur sooner and fall much closer to the initial impact point. An excursion conducted in an effort to correct this problem is reported in paragraph 5-2b below.

2. The IUA Shillelagh fired against the ATGM overwatch positions (area A), but the field Shillelagh did not detect the AGTM position. The ATGMs had no signature simulators, which may have an effect on the Shillelagh field crew's inability to detect the position. However, the field ATGM killed the Shillelagh, which indicates that intervisibility existed between the positions. This condition is also reflected in IUA, where firings occurred between the ATGM and Shillelagh positions. The Shillelagh fired two shots at tank 2 in the field. The first shot impacted at a range of approximately 1,400 meters. Field crews indicated that initial detection of the tank occurred at approximately 1,900 meters from their position, but the tank was allowed to advance 500 meters before engagement. The IUA model also fired at tanks moving through this area (B). However, the model tended to engage the tanks soon after they became visible. The second field shot at tank 2 was fired after the tank had crossed the trial termination line.

3. One other area (C) where the field and model shots differ is shown in figure 5-3. The model tended to fire at targets on trails 3 and 6 at ranges of 1,700 to 2,300 meters. The ICVs and tanks 4 and 5 were moving on these trails. There is no evidence from the field data that the Shillelagh crew did not have intervisibility with this area. It is suspected that the Shillelagh field crew either failed to detect or ignored the targets (two ICVs and one tank) in this area.



IUA ATTACKED TRAIL	ASSIGNED WEAPON
1	T62 - 1, 8
2	T62 - 9, 2
3	T62 - 5, 4
4	T62 - 6
5	ATGM - 10, 11
6	ICV - 15, 13

✚ = IUA Shillelagh 20 impact points

□ = CDEC Shillelagh 20 impact points

—— = Intervisible segment

· · · = Nonintervisible segment

✖ Shillelagh 20

Figure 5-3. IUA Trial 34 Base Case - Impact Points of Shillelagh 20 Rounds

(d) DRAGON. A summary of the DRAGON's activity for IUA and the field is shown in table 5-2. The impact points for DRAGON rounds are shown in figure 5-4 for the field trial and 10 replications of IUA. DRAGON crews completed four paired firings in the field, while the IUA DRAGON fired a total of six shots during the entire 10-replication set. The inactivity of the DRAGON in IUA was a result of the model TOWs and Shillelagh having killed most of the T62s before they moved within the DRAGON's range. The model engaged tanks 2 and 9 in the same areas as they were fired on in the field. The model also fired at tanks 8 and 4 (areas A and B). Inspection of photographs of the DRAGON's field positions indicates that this area was masked by a small hill and by vegetation near the defensive position.

(e) ATGM. The ATGMs in the field reached the overwatch area about 8 or 9 minutes into the trial but did not deliver effective fire until about 4 minutes later. The field ATGMs finally killed the Shillelagh and engaged the DRAGON. In IUA the ATGMs reached the overwatch position at approximately the same time but generally engaged (7 of 10 replications) and killed (4 of 10 replications) TOW 18 very shortly thereafter. In three replications, the ATGMs then shifted fire to the Shillelagh or DRAGON. In the remaining three replications, the ATGMs were silent, failing to detect any defender weapons.

(f) Tanks. In the field, two tanks each fired one unpaired round. In IUA there were no tank firings.

(4) Discussion. The following discrepancies between the IUA base case and field results for Trial 34 are considered noteworthy.

(a) The unarmed ICVs were ignored in the field, receiving only one round from TOW 18, which was unable to find any other targets. In IUA the ICVs were always killed.

(b) In the field trial, TOW 19 was more active than the other defender weapons, accomplishing five target engagements while each of the other weapons engaged two targets. In IUA, the Shillelagh and each TOW engaged four to five targets while the DRAGON was generally inactive, lacking many targets within its range capability. The model TOW 18 was given better intervisibility conditions than were available in the field, allowing greater activity.

(c) The overwatching ATGMs engaged more rapidly in the model than in the field, once they reached their overwatch position. This result related to the model's inability to portray the difficulty these weapons had in establishing good fields of observation and fire from within the tree line at the overwatch location.

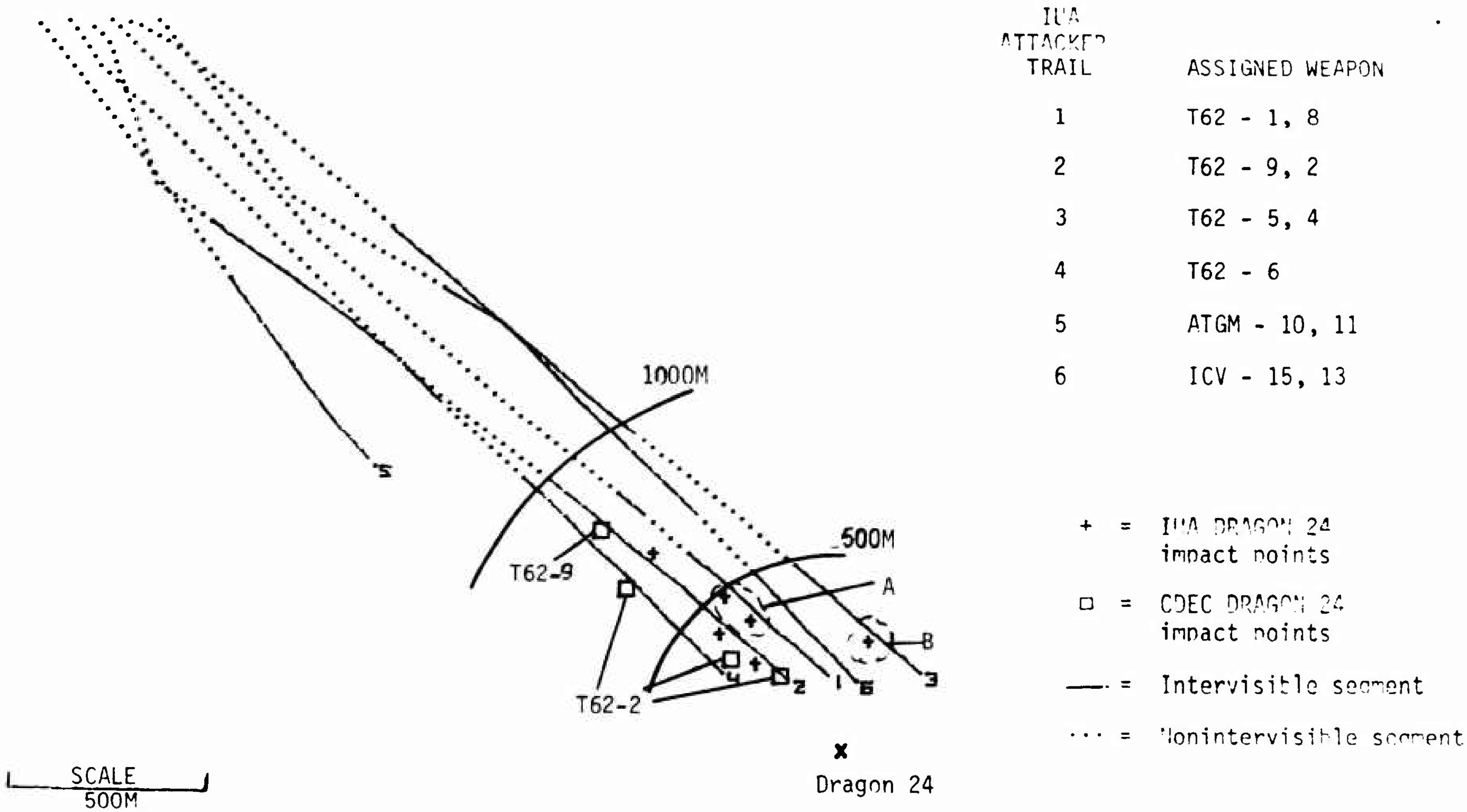


Figure 5-4. IUA Trial 34 Base Case - Impact Points of DRAGON 24 Rounds

(5) Preliminary conclusions. The IUA base case and field results for Trial 34 are considered to be in disagreement. The underlying reason is exaggeration of the capabilities of TOW 18 and the threat ATGMs because of poor portrayal of close-in vegetation. The vegetation problem points to a model shortcoming. Model logical treatment of all attacker kills as total kills also contributes to exaggerated defender weapon performance. Defenders in the model do not have to "finish off" partially killed targets and are available to engage new targets earlier.

b. Trial 34 Excursion. Players in the field trials often spent an excessive amount of time (from 35 to 59 seconds) between round impact and firing a subsequent round at the same target. Analysis of the IUA runs indicated the model defenders fired a subsequent round within 8 to 15 seconds after round impact. In an effort to test model sensitivity to changes in the parameters affecting crew engagement times, an excursion of 10 replications was run using the slower re-engagement rates of 42, 45, and 49 seconds for the TOW, Shillelagh, and DRAGON. The force outcomes for the excursion battles are shown in table 5-3, and the activity levels are shown in table 5-4. Model and field results are in somewhat better agreement. The field outcome now appears to be a possible model outcome, and the Shillelagh's model activity level is shifted closer to that realized in the field.

5-3. TRIAL 96 COMPARISONS.

a. Situation Portrayed. During Trial 96, field players executed a well controlled fire and move attack. The attackers knew the site well and made good use of available concealment. An analysis of the field trial indicated that the attacking force attempted to approach the defender positions using three platoons, with the company commander remaining in an overwatch position directing the attack. These tactics were simulated in IUA using one primary axis of advance. Four attacker trails were chosen within the axis using coordinates taken from the field data. Three platoons, each consisting of one ATGM, two T62s, and one ICV, were assigned to the IUA tactical routes. The company commander, in a T62 tank, was assigned to the remaining route. The defensive force was composed of two TOWs, one Shillelagh, and two DRAGONs. One of the TOWs, however, was poorly positioned and was inactive throughout the trial.

b. Battle Outcomes. A comparison of battle outcomes for 10 IUA replications and the field results of Trial 96 is contained in table 5-5. In terms of surviving weapons, the field results can be considered as coming from the IUA model population. Attacker weapons suffering mobility only or firepower only kills are treated as lost within IUA, as are defender weapons suffering firepower only kills; and this treatment is followed in the data tabulation. It should be noted that in the field experiment the two missing threat ATGMs suffered mobility kills. The

Table 5-3. IUA Trial 34 Excursion Outcomes

IUA Replication Number	Number of Red Weapons Surviving (T62 - ATGM - ICV) (Initial Strength 7 2 2)				Nr Blue Wpn Surv (TOW - Shill - DGN) Initial Strength 2 1 1
	Force Destroyed	Force Stopped	Some Power at Objective	Much Power at Objective	
1	-	0 2 0	-	-	1 1 0
2	-	-	-	3 2 0	2 1 1
3	-	-	1 2 0	-	2 0 1
4	-	-	1 1 0	-	1 1 1
5	-	0 1 0	-	-	1 1 0
6	-	0 2 0	-	-	2 1 1
7	0 0 0	-	-	-	2 1 1
8	-	0 1 1	-	-	1 1 1
9	-	-	2 2 0	-	2 1 1
10	-	-	1 0 0	-	2 1 1
Exp 11.8	-	-	2 2 2	-	2 0 1

Table 5-4. IUA Trial 34 Excursion (continued next page)

Defender Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		T62	ATGM	ICV	Total*	T62	ATGM	ICV	Total	T62	ATGM	ICV	Total
TOW 18	IUA												
	Mean	3.8	0.3	1.3	5.4	3.3	0.2	1.3	4.8	2.0	0.2	1.0	3.2
	Std Dev	0.9	0.6	0.6	0.7	0.9	0.4	0.6	0.7	1.0	0.4	0.4	1.0
	Exp 11.8	3	0	1	5	1	0	1	2	1	0	0	1
TOW 19	IUA												
	Mean	4.7	0.0	0.7	5.4	3.9	0.0	0.6	4.5	2.7	0.0	0.3	3.0
	Std Dev	0.9	0.0	0.6	0.7	0.7	0.0	0.5	0.7	0.5	0.0	0.5	0.6
	Exp 11.8	7	0	0	8	5	0	0	5	4	0	0	4
Shillelagh 20	IUA												
	Mean	2.4	0.6	0.9	3.9	1.9	0.6	0.7	3.2	1.3	0.5	0.6	2.4
	Std Dev	0.7	0.5	0.7	0.8	0.5	0.5	0.4	0.9	0.6	0.5	0.5	1.0
	Exp 11.8	4	0	0	4	2	0	0	2	0	0	0	0
DRAGON 24	IUA												
	Mean	0.7	0.0	0.0	0.7	0.7	0.0	0.0	0.7	0.2	0.0	0.0	0.2
	Std Dev	0.6	0.0	0.0	0.6	0.6	0.0	0.0	0.6	0.4	0.0	0.0	0.4
	Exp 11.8	4	0	0	4	2	0	0	2	0	0	0	0
Total	IUA												
	Mean	11.6	0.9	2.9	15.4	9.8	0.8	2.6	13.2	6.2	0.7	1.9	8.8
	Std Dev	1.0	0.9	1.1	1.7	1.2	0.7	0.8	1.8	1.0	0.8	0.3	1.4
	Exp 11.8	18	0	1	21	10	0	1	11	5	0	0	5

* Includes unpaired firings

Table 5-4. IUA Trial 34 Excursion (concluded)

Attacker Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		TOW	Shill	DGN	Total*	TOW	Shill	DGN	Total	TOW	Shill	DGN	Total
T62	IUA												
	Mean	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Std Dev	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Exp 11.8	0	0	0	2	0	0	0	0	0	0	0	0
ATGM	IUA												
	Mean	1.1	0.8	1.2	3.1	0.9	0.6	0.6	2.1	0.4	0.2	0.2	0.[illegible]
	Std Dev	0.7	0.9	1.8	1.6	0.5	0.7	0.7	0.9	0.5	0.4	0.4	0.9
	Exp 11.8	0	3	2	8	0	1	2	3	0	1	0	1
Total	IUA												
	Mean	1.1	0.8	1.2	3.1	0.9	0.6	0.6	2.1	0.4	0.2	0.2	[illegible]
	Std Dev	0.7	0.9	1.8	1.6	0.5	0.7	0.7	0.9	0.5	0.4	0.4	0.9
	Exp 11.8	0	3	2	10	0	1	2	3	0	1	0	1

* Includes unpaired firings

Table 5-5. IUA Trial 96 Base Case Outcomes

IUA Replication Number	Number of Red Weapons Surviving (T62 - ATGM - ICV) (Initial Strength 7 3 3)												Nr Blue Wpn Surv (TOW - Shill - DGN) Initial Strength 2 1 2		
	Force Destroyed			Force Stopped			Some Power at Objective			Much Power at Objective					
1	0	0	0	-			-			-			2	0	2
2	-			-			-			4	2	2	2	0	0
3	-			-			1	1	2	-			1	0	0
4	0	0	0	-			-			-			1	0	2
5	-			-			-			3	1	0	1	0	0
6	-			-			-			3	0	1	2	0	0
7	-			-			1	1	2	-			2	0	0
8	-			-			-			3	1	0	1	0	0
9	-			0	1	0	-			-			1	1	0
10	-			-			-			4	0	2	1	1	1
Exp. 11.8	-			-			1	3	3	-			2	0	0

model outcomes suggest a dichotomy, with the attacker being successful in five replications and defeated in five replications. Review of the detailed data failed to uncover any consistent key to discriminating between these two general outcomes.

c. Weapon Activities. Summaries of individual defender weapon activity are contained in table 5-6. The second TOW (TOW 18) does not appear in this table since it neither fired nor was fired upon in the field or in IUA; this result was apparently due to limited intervisibility.

(1) TOW 19. The overall level of activity for TOW 19 was similar in the IUA runs and the field, although this weapon fired exclusively at tanks in the field but also fired at other targets in the model. Impact points for rounds fired by the model (indicated by +) and field (indicated by □) TOW can be seen in figure 5-5. Both the field and model TOWs open fire at targets in the center of the attack formation. The field TOW fired its first round (area A) at a range of 2,380 meters in an area of intermittent visibility. The IUA TOW fired its initial round at the same target group but at a mean range of 1,980 meters and from 1 to 2.5 minutes later than in the field. The difference is due primarily to exceptionally good crew performance in the field (15 seconds from initial detection to round impact). In each case, the TOW was effective in this area, killing two tanks in the field and killing three or four of the four armed targets (three tanks and one ATGM) in IUA. After engaging the center targets, the field TOW had an inactive period of about 7 minutes and then killed the attacker's right platoon tanks in area C of figure 5-5. The model TOW, when it survived return fire from the center platoon (5 of 10 replications), then engaged targets of the attacker's right or, less frequently, left platoon (in area B of the figure) after a delay of no more than 1.5 minutes. The major discrepancy appears to be due to poor intervisibility portrayal in the model. The model TOW has a long period of intervisibility along trail 3, which did not exist in the field.

(2) Shillelagh. The levels of Shillelagh activity in the field and in IUA are comparable; however, rates of activity are exaggerated in the model. The field Shillelagh had a typical spacing of over 1 minute between shots, but in IUA 20 seconds between shots was typical. The model Shillelagh was active for only 1 minute and never survived more than 25 minutes beyond its opening shot; the field weapon was silenced about 6 minutes after its first shot. In the field, this weapon opened fire on the attacker's center, in coordination with TOW 19, and then shifted fires to ATGM 10 on the attacker's left. The IUA Shillelagh opened fire on the attacker's left platoon (area A of figure 5-6), received return fire from the attacker's right platoon, and, when it survived, shifted to return that fire. It appears that the attacker's left platoon arrived in this weapon's killing zone too early in the model, keying premature fire. This situation indicates problem with movement data rather than with model logic.

Table 5-6. IUA Trial 96 Base Case (continued next page)

Defender Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		TG2	ATGM	ICV	Total*	TG2	ATGM	ICV	Total	TG2	ATGM	ICV	Total
TOW 19	IUA												
	Mean	3.7	1.0	1.1	5.8	3.0	0.8	0.7	4.5	2.7	0.9	0.5	4.1
	Std Dev	2.0	0.9	1.2	3.1	1.7	0.6	0.8	2.5	1.7	0.7	0.5	2.4
	Exp 11.8	5	0	0	5	4	0	0	4	4	0	0	4
Shillelagh 21	IUA												
	Mean	3.1	1.5	0.5	5.1	2.6	1.2	0.5	4.3	1.7	1.0	0.5	3.2
	Std Dev	1.8	0.9	0.5	2.5	1.4	0.6	0.5	2.0	1.1	0.6	0.5	1.9
	Exp 11.8	3	2	0	5	2	2	0	4	1	0	0	1
DRAGON 23	IUA												
	Mean	0.8	0.6	0.7	2.1	0.5	0.6	0.7	1.8	0.2	0.3	0.6	1.1
	Std Dev	1.0	0.5	1.0	1.1	0.5	0.5	1.0	1.0	0.4	0.5	1.0	1.1
	Exp 11.8	3	0	1	4	3	0	1	4	1	0	0	1
DRAGON 24	IUA												
	Mean	1.3	0.2	1.4	2.9	1.0	0.2	0.5	1.7	0.4	0.1	0.4	0.9
	Std Dev	1.3	0.4	2.7	2.3	0.9	0.4	0.7	1.1	0.7	0.3	0.7	1.0
	Exp 11.8	0	0	0	0	0	0	0	0	0	0	0	0
Total	IUA												
	Mean	8.9	3.3	3.7	15.9	7.1	2.8	2.4	12.3	5.0	2.3	2.0	9.3
	Std Dev	2.2	1.0	3.3	3.9	1.6	0.7	1.1	2.5	1.5	0.6	0.9	2.2
	Exp 11.8	11	2	1	14	9	2	1	12	6	0	0	6

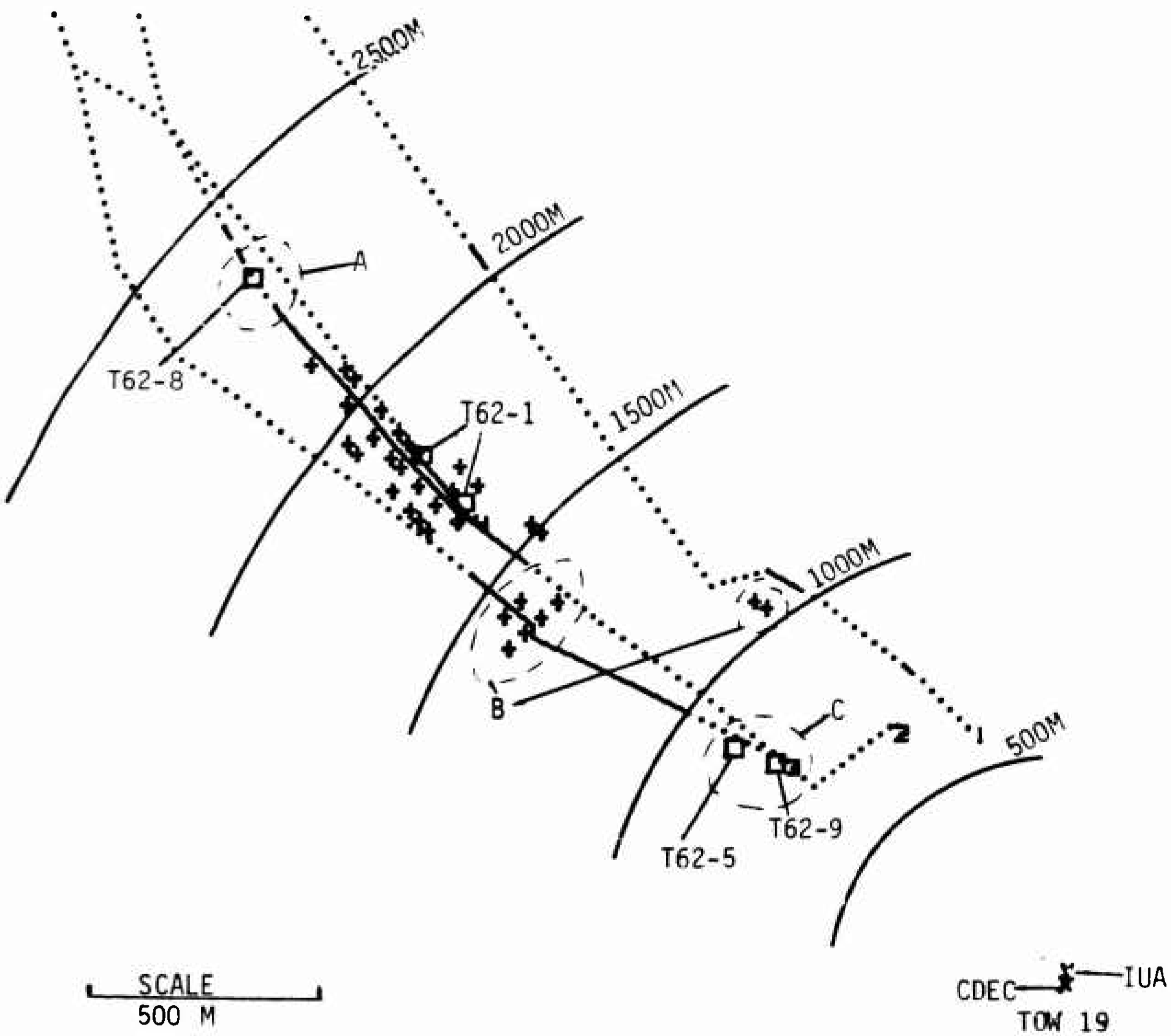
* Includes unpaired firings

Table 5-6. IUA Trial 96 Base Case (concluded)

Attacker Weapon Activity

Firing Weapon	Data Source	Rounds Fired at				Engagements of				Kills of			
		TOW	Shill	DGN	Total*	TOW	Shill	DGN	Total	TOW	Shill	DGN	Total
T62	IUA												
	Mean	3.1	4.5	4.0	11.6	2.0	1.7	1.8	5.5	0.4	0.4	0.9	1.7
	Std Dev	2.1	5.0	3.8	6.5	1.3	1.3	1.4	2.1	0.5	0.5	0.8	1.2
	Exp 11.8	0	1	7	29	0	1	2	3	0	0	2	2
ATGM	IUA												
	Mean	0.8	1.5	1.2	3.5	0.6	1.0	0.7	2.3	0.2	0.5	0.7	1.4
	Std Dev	0.7	1.1	1.7	2.3	0.4	0.4	1.0	1.4	0.4	0.5	0.8	1.0
	Exp 11.8	0	10	0	10	0	2	0	2	0	1	0	1
Total	IUA												
	Mean	3.9	6.0	5.2	15.1	2.6	2.7	2.5	7.8	0.6	0.9	1.6	3.1
	Std Dev	2.1	5.6	4.1	6.4	1.4	1.3	1.7	1.9	0.5	0.3	0.9	0.9
	Exp 11.8	0	11	7	39	0	3	2	5	0	1	2	3

* Includes unpaired firings



IUA ATTACKED TRAIL	ASSIGNED WEAPON	
1	ATGM -10 T62 - 7	ICV - 14 T62 - 3
2	ATGM - 11 T62 - 2	ICV - 15 T62 - 8
3	ATGM - 12 T62 - 9	ICV - 13 T62 - 5
4	T62 - 1	

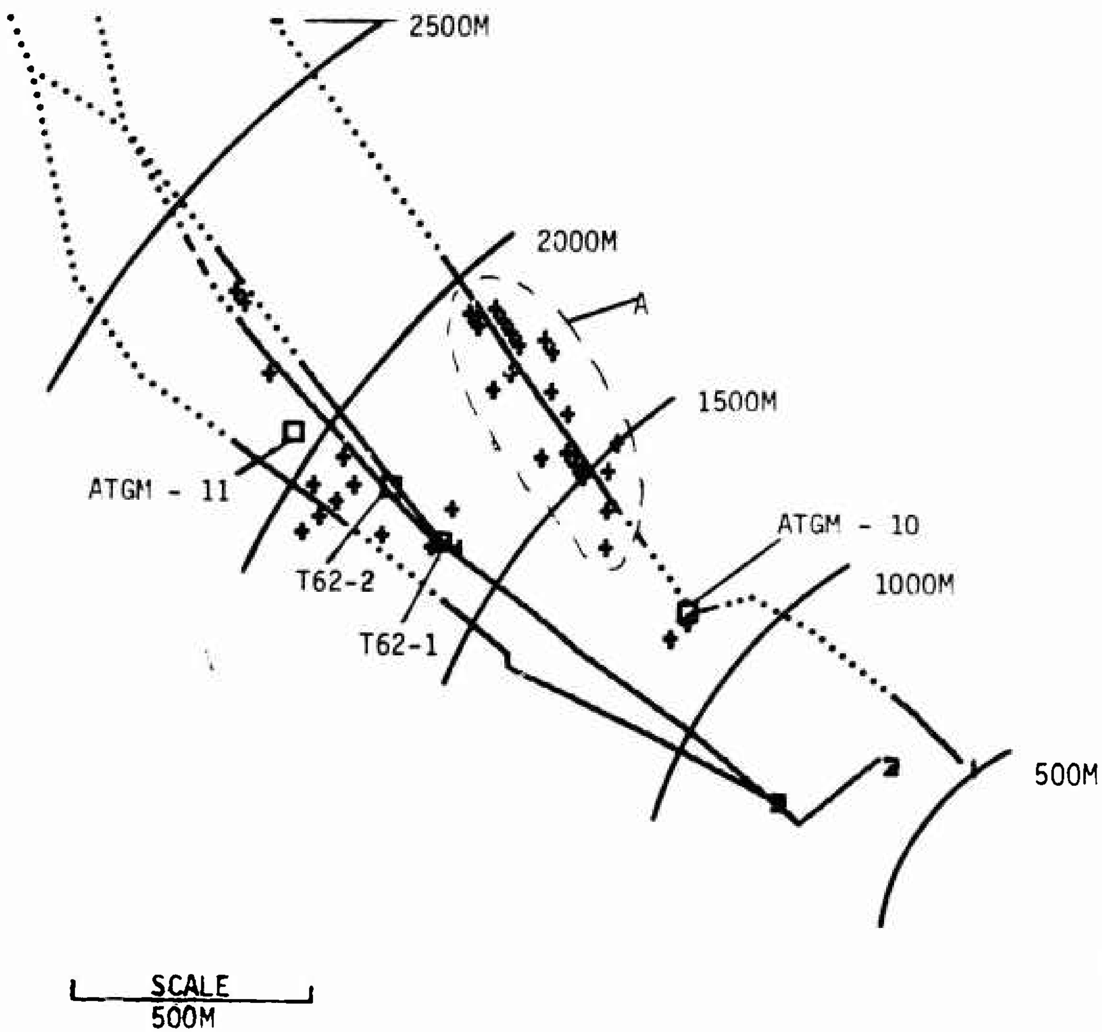
+ = IUA TOW 19 impact points

□ = CDEC TOW 19 impact points

—— = Intervisible segment

··· = Nonintervisible segment

Figure 5-5. IUA Trial 96 Base Case - Impact Points of TOW 19 Rounds



IUA ATTACKER TRAIL	ASSIGNED WEAPON	
1	ATGM - 10 T62 - 7	ICV - 14 T62 - 3
2	ATGM - 11 T62 - 2	ICV - 15 T62 - 8
3	ATGM - 12 T62 - 9	ICV - 13 T62 - 15
4	T62 - 1	

+ = IUA Shillelagh 21 impact points

□ = CDEC Shillelagh 21 impact points

—— = Intervisible segment

··· = Nonintervisible segment

✖ Shillelagh 21

Figure 5-6. IUA Trial 96 Base Case - Impact Points of Shillelagh 21 Rounds

(3) DRAGONs. Figure 5-7 shows round impact points for the model and field DRAGON 23. Intervisibility portrayal is poor, with two of the four field shots falling in areas where the model shows no line of sight. DRAGON 24 activity adds little information since this weapon received an early kill in the field and fired no shots.

(4) Threat weapon activity. The low level of paired threat weapon firings in the field (5 engagements by 10 weapons) makes direct comparisons difficult. The following points are noteworthy:

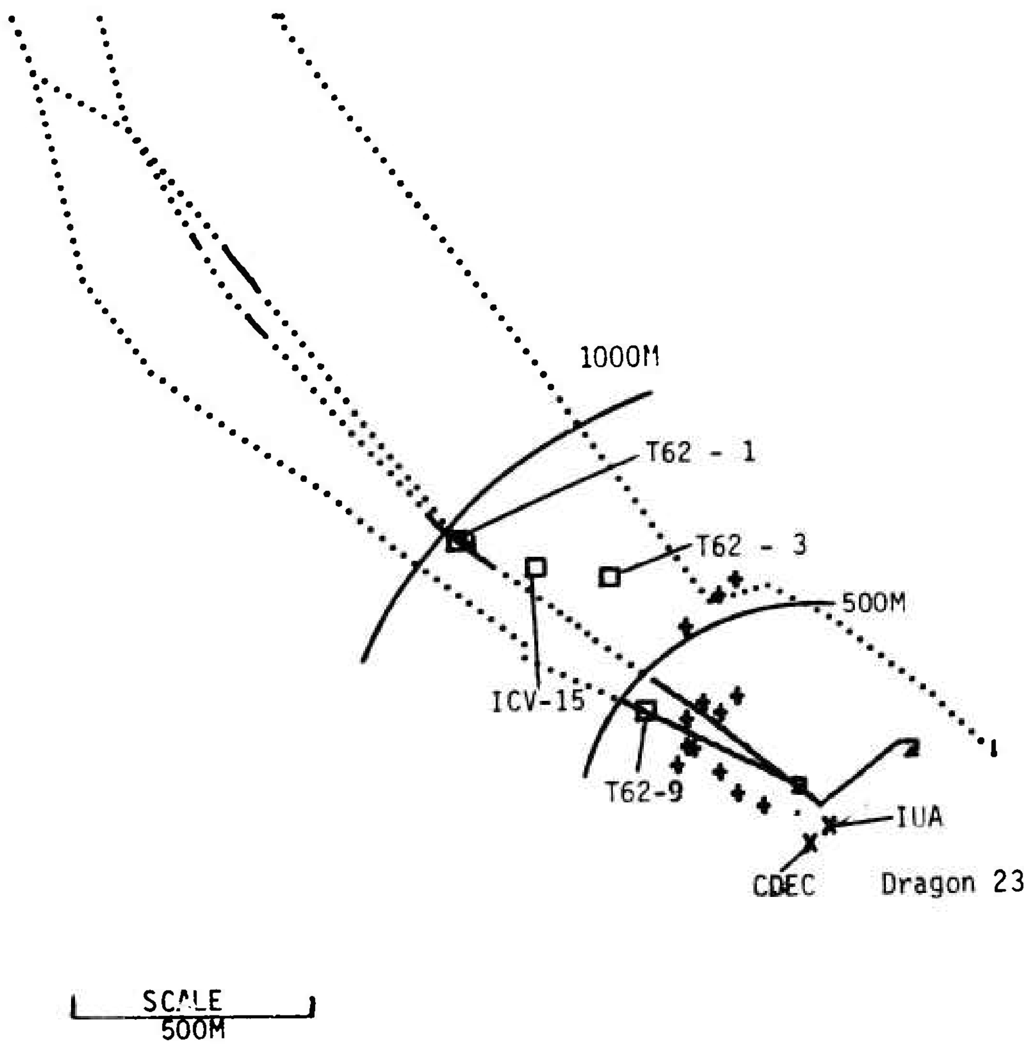
(a) The field Shillelagh was engaged by the ATGM on the attacker's right shortly after opening fire. Simultaneously, the rightmost attacking tanks fired 15 unpaired shots. This result is consistent with the model results where, shortly after its first round, the Shillelagh was fired upon by one of the rightmost attack weapons in all replications.

(b) TOW 19 was never fired upon in the field and, apparently, was never detected by the attackers. In IUA the TOW was always engaged, and the engagements followed a distinct pattern. The TOW always received return fire from one or two of the four center attack weapons (three tanks and one ATGM). This fire was initiated from the same point of the battlefield and within the same 30-second time slice in all replications. When the TOW survived this fire from the attacker's center platoon (4 of 10 replications) it was fired upon by elements of the attacker's right platoon, once more from a certain position and in a specific time window, about 3.5 minutes after fires from the center platoon. These firings at the TOW parallel the pattern of firings by the TOW in the field, except that IUA began the second active period too soon and at too great a range from the TOW.

(c) Engagements of the DRAGONs by threat vehicles were similar in the field and IUA to the extent that they were engaged by threat vehicles as they closed on the DRAGON in all cases. Differences were due to different vehicles surviving to that point.

d. Discussion. The gross results of IUA and the field experiment are not contradictory, but the model battle development is different from that of the field. The following points are major contributors to this difference:

(1) Model intervisibility is incorrect in several instances. There was model activity where detection apparently was not possible in the field, ans there was lack of model intervisibility at points where field firings took place. In many cases, this anomaly appears to be due to the model's one-way treatment of "concealment" provided in the field by vegetation. The model credits concealment when a weapon is viewed as a target but assumes that concealment has no effect when the same



IUA ATTACKED TRAIL	ASSIGNED WEAPON	
1	ATGM - 10 T62 - 7	ICV - 14 T62 - 3
2	ATGM - 11 T62 - 2	ICV - 15 T62 - 8
3	ATGM - 12 T62 - 9	ICV - 13 T62 - 5
4	T62 - 1	

+ = IUA DRAGON 23 impact points

□ = CDEC DRAGON 23 impact points

—— = Intervisible segment

... = Nonintervisible segment

Figure 5-7. IUA Trial 96 Base Case - Impact Points of DRAGON 23 Rounds weapon is a potential detector or firer. Review of the field positions indicates that TOW 19 was in a position where detection from the field was highly difficult, but the vegetation that provided this concealment effectively blocked TOW 19 from detecting or firing beyond a very narrow window. The model appears to have underplayed the TOW's restricted area of coverage.

(2) The model Shillelagh always opened the battle early, but the field Shillelagh held its fire until it could engage targets simultaneously with the TOW. This result is due to an input data problem that caused the attacker's left platoon to cross an open area too early. However, preventing this fire could only be accomplished by the use of equally faulty data that would place the platoon in the open area later than in the field. There is no way to cause the model Shillelagh to hold fire until simultaneous opening engagements take place, as happened in the field, without placing an undue range restriction on this weapon.

(3) Model firing activities, particularly sequential selection and engagement of different targets, are much more rapid in the model than in the field. This result is partially due to the fact that in the field experiment players had only a delayed feedback of the results of their fires as a destroyed vehicle stopped, showed smoke, and put out a signal panel. These actions probably took more time in the field than was appropriate. The model, however, plays no delay for target effect assessment; a firing weapon in IUA knows upon impact the effect of its round. The real world obviously lies somewhere between these extremes.

(4) Model attackers reacted to defender fires with a rapid and generally effective return of fire. The immediate reaction of field attackers is unknown. It may have been to seek cover, or it may have been confusion. At any rate, field attacker reaction was not the rapid effective return fire seen in the model.

e. <u>Preliminary Conclusion</u>.

(1) The IUA base case runs agree acceptably with Trial 96 field results. Overall results are similar when mean values are considered, but the 10 model replications produced two distinct sets of results that bracket the field outcome. The model seems to have serious problems. The visibility conditions portrayed in the model are incorrect, primarily because of poor treatment of vegetation as a close-in mask. Weapon capability is exaggerated, primarily through overly rapid acquisitions, engagements, and reactions. The treatment of any type kill as a total kill further exaggerates weapons capability for the defender.

(2) The dichotomy of IUA results led to the conclusion that insufficient replication had been used for this study. Twenty additional IUA replications were run to see if a more stable outcome would appear.

Pairwise comparisons for the mean values were carried out, using the Student's t-statistic to test the hypothesis of equality of means. Each pairwise compairson, except the mean number of Blue weapons surviving in replications 1-10 compared with replications 11-20, indicated a difference in mean values at the 95 percent confidence level. The obvious implication is that 10 replications are insufficient for this model. Comparison of the overall mean of 30 replications with the single field result did not change the conclusion that the overall (mean) model outcome agrees with the field except for the apparent overkill of ICVs.

CHAPTER 6

ADDITIONAL IUA CONSIDERATIONS

6-1. INTRODUCTION. This chapter contains a discussion of field activity that cannot be represented in IUA and of other critical model characteristics noted in the study. Most of the model assumptions discussed in this chapter have been identified in other IUA reports, but their impact on model performance has not been documented.

6-2. TACTICAL ROLES AND TACTICAL MOVEMENT.

a. Attacker Weapons. IUA plays attacking ground weapons in two tactical roles: attack overwatch weapons, which remain in a specified location and provide direct supporting fires for the maneuver weapons; and attack maneuver weapons, whose purpose is to close with and engage defender weapons.

(1) Overwatch weapons. IUA makes two critical and questionable assumptions regarding overwatch weapons. First, overwatch weapons are assumed to attain their desired firing positions through routes fully covered and concealed from the defenders. Thus, within the model, these weapons appear at their positions at a user-specified time in the battle and, for all practical purposes, do not exist prior to that point. Movements to successive overwatch positions are also possible, in which case the weapons once more disappear for a period of time and then reappear. Secondly, the model assumes that, once in its position, an overwatch weapon has line of sight to all defender weapons. In TETAM the threat ATGMs often were used in overwatch positions, and it was necessary to simulate this role. However, the model assumptions were obviously invalid in view of the field results. Consequently, for the model runs, overwatching weapons were treated as attack maneuver weapons, with obstacles placed along their routes of advance in the desired overwatch positions. Using the delay characteristics of the obstacle, overwatch weapons were stopped in the desired positions for a specific period of time to deliver fire. Their movement to the positions and fields of fire from the positions were treated with the same degree of realism as the other attack weapons.

(2) Maneuver weapons. Each maneuver weapon is associated with a route, which specifies the path to be followed and determines most of the tactical activity of the game. Each route is marked by the user with a set of up to 30 route descriptor points.

(a) A set of input critical ranges associated with the routes specify points on the route at which various actions take place. In each case, the range used to key the action is computed from points on the route to the final or "objective" point of the route. Important range points for ground direct fire weapons are:

1. Line of departure. The simulation actually starts at this point on each route.

2. Tactical line of departure. This is a phase line. Maneuver weapons hold at this line until it is reached by all maneuver weapons.

3. Overwatch line. Overwatch weapons appear in their positions when maneuver units reach this line.

4. Defender open fire line. Defender weapons do not fire until this line is crossed by attackers.

5. Move and fire line. Maneuver weapons begin to execute fire and movement when these points are reached.

6. Mass fire line. Maneuver weapons stop fire and movement at this line. Weapons hold at this line until it is reached by all maneuver weapons and then continue to advance.

7. Defender withdrawal line. Where secondary defender positions are used (discussed below) the movement to these positions is keyed to attacker arrival at this line.

8. Moving fire line. Attack maneuver weapons with the capability to fire while moving are allowed to do so once this line is reached.

(b) Keying of the various critical lines introduced above is accomplished through timing flags set in the movement preprocessor. The events take place in the battle model at their scheduled times, regardless of the actual dynamics of the battle. For example, if weapons are scheduled to wait at the mass fire line they will wait for the scheduled time, even if the weapons they are nominally waiting for have been killed. As another example, if defenders are scheduled to withdraw on schedule even if the attackers keying the withdrawal have been killed and regardless of the attacker's strength.

(c) Attacking maneuver weapons execute a fire and movement tactic between the fire and move line and the mass fire line. To accomplish this tactic, two "sections" on a given route advance by either successive or alternating bounds.

1. Given a sequence of points along the route, with point N the point at which fire and movement starts, successive bounds move section 1 to point N+1 while section 2 holds at point N. As section 1 reaches point N+1, it holds there and section 2 moves to point N+1. When section 2 reaches point N+1, it holds and section 1 moves to the next point. This process continues until the mass fire line is reached.

2. To simulate alternating bounds, section 1 moves to point N+1 while section 2 holds at point N. When section 1 reaches point N+1, it holds and section 2 moves to point N+2. When section 2 reaches point N+2, it holds and section 1 moves to point N+3. The "leap frog" process continues until the mass fire line is reached. The points along a route used are those input route descriptor points that lie between the fire and move and mass fire lines. Once more, the movement is scheduled by the preprocessor and, for example, if section 2 is killed, section 1 continues its bounds and waits at the prescribed points as though it were waiting for section 2 to complete its bounds.

(d) Attack maneuver weapons may be identified as having a capability to fire while moving; otherwise, they must stop to fire. (In the TETAM runs, all weapons had to stop to fire, consistent with the rules of the field experiment.) Weapons with the moving fire capability are allowed to do so when the appropriate critical range is reached. Otherwise, firing is possible only when the vehicle stops. A vehicle can stop only at the tactical line of departure, at firing points while executing fire and movement, at the mass fire line, and at obstacles. Each of these stopping points, or potential firing positions, is one of the route descriptor points (at most 30 per route) provided by the user. Consequently, the user must exercise great care in selecting these points to insure that they provide sufficient intervisibility to defender positions, since these points may be the only ones from which firing is possible.

(e) Local concealment levels are defined at each route descriptor point, and the concealment level at one point is applied over the route until the next point N reached. Nominal concealment levels are fully concealed, partially exposed, and fully exposed. This concealment along a route impacts on the defender's ability to detect and subsequently engage an attacker but has no direct impact on the attacker's ability to detect a defender. There is no model relationship between this type of concealment, dictated by the user, and the model's terrain representation. Thus, any consistency with the terrain being represented is provided by the individual developing the route descriptor points.

(f) Maneuver weapon movement rates are computed under the assumption that all movements take place at the maximum possible speed, limited only by terrain roughness, soil type and slope characteristics, and vehicle capacity. As with concealment, the roughness and soil characteristics are input with route descriptor points; so, within the model, no recourse is required to the terrain data except for slopes. Movement is accomplished in the preprocessor by scheduling the arrival time of a section at each route descriptor point, with the travel time between points based on the limiting velocity of the section's lead vehicle. (Lead vehicles are specified by input.) The scheduled movement is not affected by dynamic battle events. For the TETAM situations, model vehicles moved much faster than their field counterparts; in fact, the assumption of movement at terrain-limiting speeds was invalid. The comparison runs discussed in chapter 5 were actually made with artificial data developed to force model movement consistent with that realized in the field.

(g) The only meaningful attempt to portray tactical organizations or formations within IUA takes place in the fire and movement activities followed by sections, as discussed above. This section logic is the basis upon which most of the model depends, and it leads to various numeric limitations: there must be two sections per route, one to three weapons per section, one to 12 routes, and at most 72 maneuver weapons. Coordination among routes is accomplished through the various critical ranges, such as those described above, regardless of battlefield dynamics. Coordination between sections on a route is also predefined regardless of battlefield dynamics. Individual activity within a section is superficially defined in terms of individual firings or losses, but the section actually moves, detects, and is detected as an entity. The section's position along its route is used to determine such factors as range, concealment, and intervisibility, which are applied to each weapon of the section. The IUA postprocessors assume that sections were in a line formation with 50 meter interweapon spacings when providing individual weapon locations for output, but there is nothing within the preprocessor or the actual battle simulation that is affected by this assumption.

b. Defender Weapons. The IUA model allows the user to specify primary and secondary defender weapon positions. Movement to secondary positions is keyed to attack weapon arrival at one of the critical ranges discussed previously. As with other major tactical decisions in IUA, the movement is prescheduled and cannot be affected by battle dynamics. When the movement takes place, the assumption of perfectly covered routes is made, with the defenders disappearing and then reappearing at their secondary positions.

6-3. TARGET ACQUISITION AND INTELLIGENCE. The play of intelligence and target acquisition within IUA is the most questionable area of the model. Unfortunately, it is one of the most significant factors determining individual weapon activities in the field.

a. Battlefield Intelligence. For the purpose of this discussion, intelligence is considered as the sharing of information among elements of a force, as opposed to individual target acquisitions made by discrete elements. In this context, IUA makes no explicit representation of intelligence. However, where tactical or fire control decisions are made that would logically require some intelligence, there is an implicit assumption that the required information is available instantly. For example, the various control lines, which imply knowledge and coordination of friendly locations, are acted upon automatically.

b. Aggregated Acquisitions. Once a maneuver weapon detects a defender, all weapons in the section have knowledge of the defender. This could be an implicit assumption of instantaneous intelligence within the section. However, it is more likely an attempt to aggregate detection at the section level since the inverse relation also holds true; that is, once a defender detects, he detects the full section. The net result is that a section composed of one element and a section composed of three elements would, in the same situation, detect and be detected identically. This type of aggregation has no basis in fact.

c. Basic Acquisition Algorithms. The basic IUA procedures for determining target acquisition are a set of algorithms for which no empirical basis is known. Three areas are considered: acquisition of firing targets, acquisition of nonfiring targets, and detection time. Throughout these discussions, when a detecting or target weapon is cited, the same logic applies with no adjustment to an attack maneuver section.

(1) Detection of firing weapons.

(a) The probability of detecting a firing target (weapon or section) is computed as:

$$P_A=1-(1-P_R)^{NK}$$

where:

P_R = probability of detecting the target based on a single firing

N = number of rounds the target (weapon or section) has fired while maintaining intervisibility to the potential detecting weapon or section

K = 1 if potential detection weapon (section) is moving

K = 1.5 if potential detecting weapon (section) is stationary.

Each time a weapon (section) fires, all opponent weapons with intervisibility have an opportunity to detect. The detection is based on comparison of a random draw (uniform, 0 to 1) to P_A. The formulation is superficially reasonable to the extent that detectability increases for a stationary observer as a potential target is more active. The formulation, however, is unsound from a probabilistic point of view, both by the cumulative entry of N and by the aggregated treatment of maneuver sections. Further, the adjustment factor K is arbitrary. If the input value of P_R is at all reasonable, this formulation must lead to excessive detections.

(b) An alternate formulation of probability of detecting a firing weapon is found in the IUA version used for a TACOM concept evaluation supporting the XM815 Tank Program Office. The formulation used is:

$$P_A=1-(1-f_m\ f_s\ P_R)^K$$

where:

P_R = as defined for the original version

f_m = an adjustment for observer motion (data used set f_m essentially to one for ranges out to 1,000 meters)

f_s = an adjustment factor of undetermined nature (data used increase with range, f_s = .06 at 500 meters and f_s = .35 at 4,000 meters)

K = 1.5 for defender or attack overwatch

K = 1 for attack maneuver sections.

This formulation discards the cumulative treatment of rounds, an improvement at least on theoretical grounds. It is impossible to comment further since the basis of f_s is unknown and, from inspection of values used, this element appears to be the dominant factor in the formulation. This formulation gives a significantly lower detection rate than the original algorithm.

(2) Detection of nonfiring weapons. Visual detection of nonfiring weapons is based on comparison of a random draw to a probability of detection. The check is made (opportunity to detect) each time an attacker establishes intervisibility with a defender and when an attacker with line of sight moves into a new 500-meter range band, starts to move, or moves to a concealed route. Probability of detection is based on input tables for probability of detecting a moving or stationary standard NATO target (7.5 feet square), developed for 500-meter range bands, out to a maximum of 4,000 meters. These probabilities may be subject to further input multiplicative adjustments based on target type, but ground rules for development of the factors are not clear. In addition to intervisibility status, a number of range concealment and target motion checks must be passed to provide an opportunity to detect; for example: attackers must be within 250 meters of their objective to detect any defenders by this means, any fully concealed defender or attacker on a fully concealed route cannot be detected by this means, a stationary attacker more than 250 meters from his objective and a moving attacker more than 750 meters from his objective must be fully exposed for this type of detection to take place, and in the 250 to 750 meter band a moving attacker may be detected under partial cover or concealment. The various range criteria and the basic probability of detection are all based on the range between an attack weapon (section) and its associated objective point, not true range between weapons. Movement of the potential detecting weapon is never considered, except possibly by implication, since the defender is stationary. The various factors and critical ranges may be intuitively appealing, but there is no known empirical basis for this formulation.

(3) Detection times. Given the Monte Carlo determination that a detection is to take place, the detection by means of a firing cue is immediate. Detection of a nonfiring target, however, is scheduled to take place at a future "acquisition time," if and only if line of sight

will exist at that time. (Since line of sight is preprocessed, the model has access to this information.) The model develops this time by first making a random draw (using an input cumulative distribution table) for a basic value and then applying a multiplicative adjustment factor. The basic value is keyed on whether the target is moving or stationary. The adjustment is keyed on target type, range band, and whether the target is moving or stationary. The implied distributional form of detection times is not clear from review of the model or data traditionally used. The basic times used are larger for stationary than for moving targets; but adjustment factors, which increase with range in either case, are greater for moving targets. The net result is that detection of a moving target is generally faster than detection of a stationary target, but times increase more rapidly with range for the moving case, and the two processes tend toward similar values at extreme ranges.

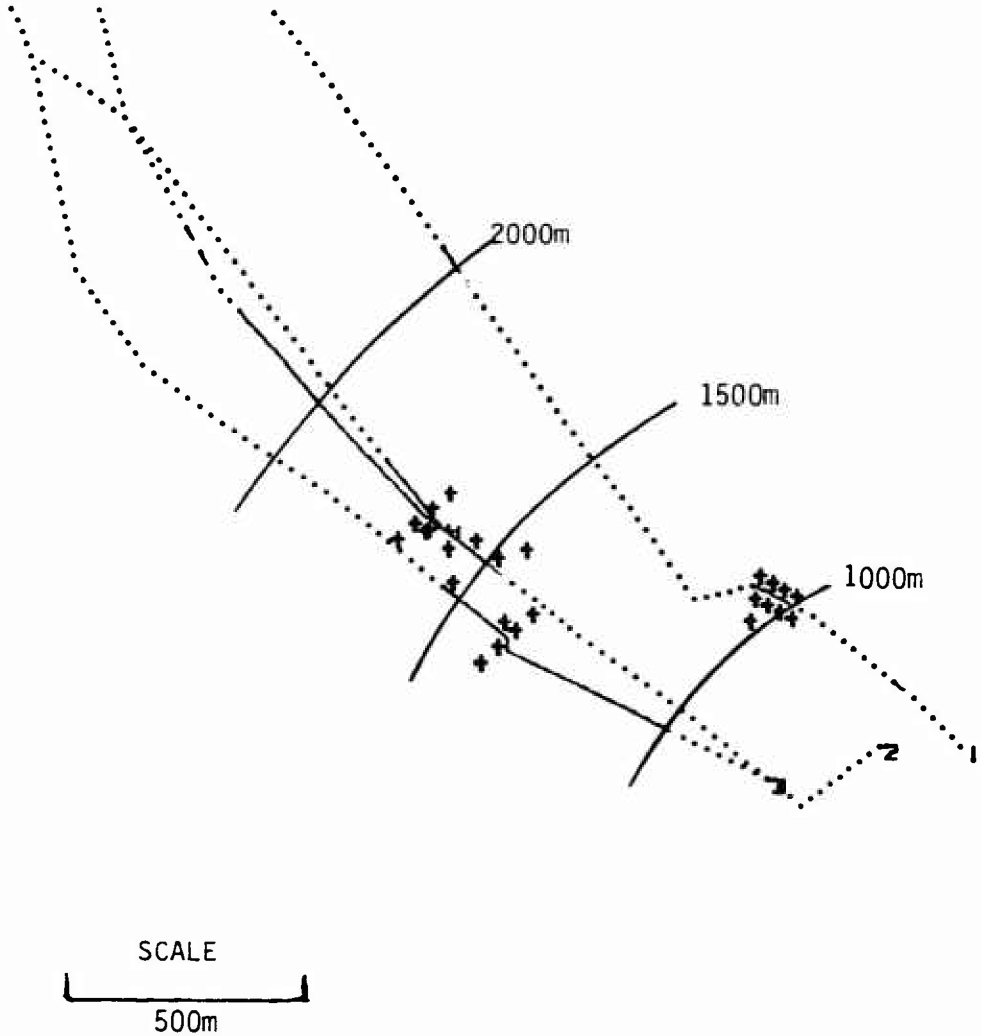
(4) Critique. The detection algorithms of IUA are weak. A major problem is the aggregation over attack maneuver sections. This aggregation is consistently incorporated throughout the logic but is not emphasized in available documentation. In the general case an attack maneuver section, composed of one to three entities, is treated with the same logic and data as an individual defender or attack overwatch weapon. A second major problem area is incorporation of the detection logic into the overall model logic. An opportunity to detect firing weapons is given each time the weapon fires, but the result depends on a cumulative round count, which is probabilistically incorrect. For nonfiring weapons determination of whether detection takes place and the detection time, followed by an intervisibility check at detection time, appears to be incorrect. The model is apparently treating a set of unconditional probabilities in a conditional sense, introducing redundancies. Given sufficient time and continued capability, the probability of detecting should approach unity. Thus, if calculation of a detection time were appropriate, and the final line-of-sight check were sufficient to insure continued capability, the initial check on whether detection takes place would be inappropriate. A third shortcoming is that as long as the defender does not move, one acquisition of a given attacker or defender by a given opponent suffices throughout the battle; that is, intelligence is never lost in the sense that once a target has been acquired it does not have to be reacquired. It may be temporarily impossible to engage a target because of lost intervisibility; but once intervisibility is reestablished, the target can be engaged with no reacquisition requirement.

d. <u>Intervisibility</u>. Intervisibility is a prerequisite to target acquisition. The play of intervisibility in IUA, even as improved for TETAM, is lacking. Room for further improvement is limited, however, since IUA's portrayal of intervisibility is probably sufficient for the uses made of this information within the model. Since the aggregated play of maneuver sections is ingrained within the model structure, more detailed play of intervisibility would be superfluous. One plausible area of improvement would be to incorporate the concept of concealment into a terrain preprocessor. The detection rules allow use of the concealment factor along an attacker route to bias a battle. Suppose that the model is being used to simulate a T62 tank force closing from 3,000 meters on a TOW position. If it is assumed that the tank commanders will make maximum use of local vegetation and remain partially concealed during their movements from 3,000 meters into initial firing positions at 1,500 meters, and this restriction on the tank routes is input, then the TOW gunners will be unable to acquire and engage the tanks beyond 1,500 meters. During Trial 34 in the field, ATGMs moved along the edge of a wooded area into their initial overwatch positions and were not detected by defensive gunners. Local vegetation was used in the model to simulate this movement. During Trial 96 IUA base case runs, local vegetation was not played on any of the attacker trails. An excursion run was conducted in which attacker platoons were allowed to move into their initial firing positions along concealed routes. An example of the resulting change in defender firing patterns can be seen in figure 6-1. The figure shows the round impact points for IUA TOW 19. Compared with the base case impact points in figure 5-5, the TOW's opening engagement range in the base case of 2,150 meters was reduced to 1,650 meters in the excursion run. The user must exercise extreme care when playing local vegetation in IUA, especially if the defensive force contains TOWs, Shillelaghs, DRAGONs, or other weapon types whose effectiveness depends on long range detections and engagements.

6-4. FIRING SEQUENCE. The basic sequence involved in firing a weapon is represented within IUA by a target selection process, time delays for firing and projectile flight, and assessment of the effects of the firing. Assessment logic paralleling that used in the TETAM field experiment was used in this study, and that portion of the IUA logic was not reviewed. The aggregated treatment of sections noted elsewhere does not appear in the firing logic.

a. Target Selection. Target selection in IUA is based on a relatively simple target priority and selection rule scheme.

(1) for each firer, each potential target type has an intrinsic priority ranging from 0 to 5. Five is the highest priority, and a zero-priority target will never be engaged. These values are input. The effective priority of a target is the sum of intrinsic priority plus 3 if the target is associated with the same axis of advance as the selecting weapon plus 1 if the selecting weapon is an attack maneuver weapon and the target is associated with that weapon's route. (Effective priority is zero if intrinsic priority is zero.) The axis weight appears to be meaningless since detection logic inhibits any off-axis detections.



× TOW 19

IUA ATTACKER TRAIL	ASSIGNED WEAPON	
1	ATGM-10 T62-7	ICV-14 T62-3
2	ATGM-11 T62-2	ICV-15 T62-8
3	ATGM-12 T62-9	ICV-13 T62-5
4	T62-1	

\+ = IUA TOW 19 impact points

— = Intervisible segment

... = Nonintervisible segment

NOTE: Excursion allowed attackers to advance to initial positions using concealment of local vegetation

Figure 6-1. IUA Trial 96 Excursion - Impact Points of TOW 19 Rounds

(2) In the absence of a current target, a selecting weapon engages the highest priority target for which it has appropriate ammunition from the group it has acquired that are not already selected by weapons in the same section (if the selecting target is an attack maneuver weapon) or by weapons covering the same axis (defender weapon selecting). Lacking such a target, the highest priority available target being engaged by the same section or on the same axis will be selected.

(3) If the selecting weapon already has a target, it will shift to a higher priority target not already assigned to a cooperating weapon. Lacking such a higher priority target, the currently assigned target is retained, unless the weapon is no longer to engage because it is out of appropriate ammunition. In that case, the shift is to the highest priority target already selected by a cooperating weapon. It appears that weapons of priority equal to or lower than that of the original target but not selected by cooperating weapons are missed by a logic oversight.

b. Keying Target Selection. A weapon has an opportunity to select targets in every instance where, by overall model logic, selection would be possible; that is, on every acquisition, on completion of any firing, and whenever a firing sequence is interrupted. Additionally, for a defender, opportunity to select is available when line of sight is established with a previously acquired target and, for attackers, on arrival at a firing point, on initiation of a segment where moving fire is allowed, and on gaining intervisibility on a moving fire segment.

c. Line-of-Sight Checks. The firing sequence is appropriately halted by line-of-sight interruptions at selection time, at firing time, and, if the projectile is guided, at impact time.

d. Calculation of Delays. Upon target selection and the implicit decision to fire, delays are computed to allow scheduling of a firing event and, after projectile flight, an impact event. The flight time comes from a simple calculation based on projectile velocity. Calculation of firing delay times, however, is more complicated. Response time is the sum of a variable and a fixed response time component, under the constraint of a minimum allowable response time. The basic assumption appears to be that the variable component is lognormally distributed. Median response times for initial and subsequent rounds must be provided as input for each weapon by range to target bands. To this value, a multiplicative "correction factor" is applied if the target is moving. If the target is not moving, a difference correction factor is applied if the firer is moving. (The inability to apply both correction factors is not inconsistent since a moving defender in IUA can neither fire nor be fired upon. Thus, it is impossible for target and firer to move at the same time.) The distribution appears to have a constant deviation assumed, since random selection about the median is accomplished by the technique of entering a single cumulative distribution table for the lognormal. All variables; that is, the median response, correction factors for target or firer motion, the additive fixed response, and minimum response are required data for each firing weapon round type, for first and subsequent rounds, and for incremental range bands. This formulation places the weight of validity on the data developer.

e. Use of Delays. The application of delay times, calculated as discussed above, is questionable in IUA. The most serious problem is the fact that since initial round delays are generally smaller than subsequent round delays, a weapon tends to shift fire to a new target upon either killing or ceasing fire at a previous target much more rapidly than it fires a second round at the original target. This condition is partially due to the fact that there is no way to input a delay time for the crew to assess the effects of its fire except by incorporating it into the subsequent round delays. Additionally, target selection is, for all practical purposes, instantaneous.

f. Result of Partial Kills. A highly questionable treatment of partial kills (mobility only and firepower only) was noted. For any partial kill other than a mobility only kill to a defender, the weapon essentially disappears from the battlefield. This is also the case for weapons that run out of ammunition since these weapons then are treated as firepower kills.

g. Critique. The target selection logic of IUA and its incorporation into the model is simple and direct, as are its data requirements. The logic could be made more complicated, but there is no apparent need to do so considering the lack of sound supporting detail in other portions of the model. On the other hand, the calculation and use of firing delay times are obscure, although the program logic is simple. This obscurity is due to the apparent lack of any documented basis for the treatment embedded in the model and the lack of available guidelines for the data developer. No documented basis has been found for the use of a lognormal distribution or the assumption of different median times but constant variation over various conditions. Further, the user is left to his own devices in deciding what conditions should be considered in providing the various time components, correction factors, and minimum times. Finally, the treatment of partial kill categories is obviously incorrect. Weapons suffering firepower kills can still move, detect, and be targets. Weapons suffering mobility kills can still detect, fire, and be fired upon. There may be an implicit assumption that the crews of weapons suffering such damage cease to function, but even in this case the vehicles still remain as targets on the battlefield.

6-5. ERRORS IN THE MODEL. Several coding errors were discovered during the model validation. Some were traced to errors introduced while the model was undergoing various modifications at CACDA. However, three of the coding errors causing substantial logic changes in the model were found in all CACDA versions including the original Lockheed version. These errors were corrected before the TETAM validation runs were conducted.

a. Errors in Subroutine LOS.

(1) Two of the errors were found in the terrain processor program, TERVAR. The IUA terrain is represented by a series of adjacent triangles, each having different slopes. Heights of dense forests covering the triangles are also input with each triangle. The coding errors occurred in subroutine LOS. In this subroutine intervisibility between a potential firer and a target is determined by passing a ray between the firer and the target locations. The model then moves along the ray comparing its altitude with the altitude of points on the edges of the terrain triangles that are intersected by the ray. If the comparison shows that all terrain points fall below the ray, then line of sight is assumed to exist between the target and firer. The first error was found in the method used to move along the line-of-sight ray. If the ray passed over the vertex of several triangles, the model attempted to move into the triangle containing the ray by adding ΔX and ΔY to the coordinates of the vertex (where the values of ΔX and ΔY are 1×10^{-3}). This method did not work for one of the TETAM tank trails. The method caused the model to move into a triangle not containing the line-of-sight ray. This problem was corrected by adding ΔX to the X-coordinate of the vertex and calculating a new Y value using the slope of the line-of-sight ray.

(2) A second error was found in the method used to calculate vegetation height. As the line-of-sight ray crosses the edge of a triangle containing dense vegetation, the height of the ray is compared with the terrain altitude plus the vegetation height at that point. The vegetation height was calculated by averaging the input heights for the current triangle and an adjacent triangle. If the adjacent triangle has no vegetation and the current triangle contains a dense forest, this logic results in the forest vegetation being played at one-half the height specified by the input data. This averaging process was deleted from the model so only the vegetation heights input for each triangle were used during calculation of line of sight across that triangle.

b. Errors in Subroutine ASSIGND. The times required for a defender to respond to a target by loading, pinpointing, and firing a round are calculated in the IUA main battle model by subroutine ASSIGND. The response times are calculated for engaging stationary targets. For moving targets the stationary response times are multiplied by a factor representing the increased difficulty in pinpointing the target. The variable

FRCRT is currently being used as the pinpoint factor for defenders engaging moving attackers. It should be changed to RTKRT, which contains the correct defender response factor. Correction of the errors described above resulted in substantial changes in model results. Any version of the IUA battle model and the terrain processor should be checked for these errors before use in any study effort.

6-6. SUMMARY.

a. The following observations are based on detailed comparisons of IUA and Experiment 11.8 results for Trials 34 and 96.

(1) The battle outcomes observed in IUA are not contradicted by field trial results. This finding applies to the Trial 34 excursion runs, made with adjusted firing rates, and the Trial 96 runs in the sense that the field could be said to be a realization of the same populations represented in IUA results. However, these general outcomes occur in distinctively different patterns in the model when compared to field results.

(2) The greatest discrepancies between model and field results can be traced to flaws in the model representation of intervisibility. These flaws can be defined further as cases where the model clearly blocked line of sight that was known to exist in the field. Less clearly defined but more prevalent is the poor representation of the effects of vegetation.

(3) Model logic that leads to the treatment of various partial kills (mobility only, firepower only) by removing the partially killed vehicle from any further consideration as a potential target or firer is incorrect. This logic contributes to an overstatement of the capability of weapons on both sides to engage sequentially a number of targets and probably is biased to favor the defender.

(4) The overstatement of ability to engage targets sequentially, cited above, is further amplified by the model's lack of consideration of any damage assessment delays or uncertainties.

(5) A uniform tendency of attackers to produce effective return fire rapidly is apparent in the IUA runs but not in the field.

(6) The IUA target priority rules do not allow portrayal of coordinated opening fire tactics apparently used in the field, nor can the model reproduce the sporadic engagements of ICVs noted in the field.

b. A high level of IUA replication (more than 10 replications) is needed to develop satisfactorily stable results.

CHAPTER 7

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

7-1. GENERAL.

a. This chapter summarizes the findings and conclusions of the TETAM Model Verification Study pertaining to the degree of fidelity with which DYNTACS and IUA represent essentials of the type small unit actions investigated in Field Experiment 11.8 and identifies recommended areas for model improvement.

b. The model investigations of this study were limited to model portrayal of small unit tank-antitank engagements and the associated interchange between direct fire weapons. Various additional aspects of the models or field experiment, such as the protrayal of aerial and air defense weapons, indirect fire weapons, minefields, or reduced visibility conditions were not reviewed in this study.

c. For each model, a summary of findings and conclusions is presented covering the following general topics: overall battle outcomes; portrayal of intervisibility; portrayal of target acquisition, combat intelligence, and communications; portrayal of tactical movement; and portrayal of target assignment, handoff, engagement, and kills. Recommended areas for model improvement are identified, and attempts are made to assign priorities on the dual criteria of estimated payoff in terms of improved model fidelity and relative estimated levels of effort required to accomplish the change.

7-2. DYNTACS FINDINGS.

a. Battle Outcomes. Results from the two field trials could be viewed as samples from the respective outcome sets of 10 DYNTACS replications, with the following limitations:

(1) DYNTACS defender weapons consistently engaged and killed the unarmed threat ICV, which were generally ignored in the field. It would be possible to prevent model engagements of the ICV, or to limit them on a range basis, but it would be impossible to portray the sporadic engagements noted in the field.

(2) The DYNTACS base case runs for Trial 96, when compared to the field outcome, consistently overstated the survivability of the attacking force. This result can be traced to an exaggerated ability of the attack weapons to detect and kill rapidly the key defender weapon in the field, in this case a TOW. With the decreased detectability of firing weapons investigated in the Trial 96 excursion runs, the field outcome is represented in the set of model outcomes.

b. Intervisibility and Associated Environmental Representation.

(1) A conclusion of the follow-on intervisibility study, reported in Volume II, was that the independent factor treatment of cover (as provided by the landform and major forest-type vegetation) and concealment (as provided by vegetation close in to a target) did not permit a reasonable portrayal of detection opportunities. An alternate procedure, which removed this differentiation, showed promise in that investigation and was used in the DYNTACS runs reported here.

(2) A continued intervisibility problem was manifested through consistent patterns of model firings into areas where field firings, player debriefings, and positional review indicated a general inability to acquire and engage targets or, conversely, through a lack of model acquisition or firings in areas where field firings took place.

(a) Review of the detailed model and field data generally indicated that where firings occurred in the field they could be carried out in the model. Exceptions were noted in several instances where model firings seemed to lag field firings. In the field, when an attacker broke out of a tree line he was almost immediately engaged by a defender, indicating that some of the vegetation in the field permitted detection but inhibited firing. In the model both detection and firing were inhibited in the sense that sufficient visibility for engagement is assumed if detection can take place. Several other instances of field firings unmatched by the model firings were noted but were explained by consistently early loss in the model of the weapon that fired in the field.

(b) Numerous instances of model firings where there was no firing in the field were noted. Most of these firings were model firings at the ICVs, which provided no useful information on intervisibility since field defenders tended to ignore the unarmed ICVs. The remaining unmatched model firings fell into two categories, occasional firings by a given weapon in an area (one or two occurrences in the 10 replication set) or consistent firings into an area (repeated over most replications). The occasional firings into an area may be explained by intermittent patches of intervisibility, typical of the area in which the experiment was conducted, to which a defender might get a chance shot on occasion. The fact that a model defender gets the shot, but only on occasion, and the field gunner did not get the shot in his one chance may be interpreted as supporting the validity of the model representation. Consistent firings into areas where no field firings took place were noted in three instances (by both DRAGONS and one TOW in Trial 96). In two of the instances (the DRAGONS), the weapons had been killed at an earlier stage of the field trial, thus allowing no inferences as to whether intervisiblity would have taken place in the field. In the third instance the field weapon was silent throughout the trial, apparently indicating total blockage from the axis of advance. In the model, this weapon fired into two well-defined firing zones along one edge of the axis of advance. The most probable explanation is that the model weapon had a slightly greater fan of coverage due to poor portrayal of terrain in the vicinity of the TOW's position. Another possible explanation is that the field weapon failed to pick up the targets as they passed through these zones (this happened in the model on 5 of the 20 Trial 96 base case and excursion runs).

(3) Based on the points discussed above, there is no conclusive evidence to indicate a serious shortcoming in the DYNTACS portrayal of intervisibility.

c. Intelligence and Communication.

(1) The sole function of the communications model in DYNTACS is to pass target information among elements. Under this limitation, the functioning and structure of the DYNTACS communications module appears to be reasonable. However, there is no portrayal of movement and fire control dependence on communications. The implicit assumption that these control functions are not limited by communications is contradicted by Field Experiment 11.8.

(2) There is no way to generate false targets in DYNTACS. Firing at false targets is a real-world phenomenon and is a partial explanation of the unpaired firings in Experiment 11.8, which constituted over half of the attacking force's firing activities.

(3) An individual element has one of four levels of knowledge of each enemy element: none, general area, full, or pinpoint. Weaknesses are notable in treatment of the general area and pinpoint levels. The pinpoint level was originally defined as being present when an element could lay its weapon on the firing signature but had no clear view of a target; however, there is no longer a clear definition of pinpoint knowledge as currently used in the model. This lack of clear definition may not be a serious problem, but the model logic that causes firing at such a target is invalid for an antitank guided missile. Treatment of the general area level of knowledge may be invalid in that this level of knowledge never deteriorates.

(4) Fire control and movement control logic depends upon implicit assumptions of the general state of knowledge that appear unfounded. Full knowledge of the status and position of all friendly elements is assumed by the model. Additionally, knowledge of all enemy kills is instantaneous in that a "dead" target will not be detected, will not be fired at, and will not affect movement control decisions.

(5) Incorporation of intelligence into the event sequencing logic of the overall model is weak, particularly in the timing relation between detections and intervisibility checks and between detections and any action taken upon a detection.

d. Target Detection. Target detections in DYNTACS are made through four processes: random detections based on visual search, detection based on firing cues, detection based on an intensive visual search of the area about a newly detected or fired upon target, and pinpoint detections.

(1) Random visual detections.

(a) The key portion of the algorithm used to represent random detections by visual search is the determination of detection rates. This determination is based on empirical data but is suspect because of the limited conditions under which the data were gathered and the inclusion of a highly subjective "terrain complexity" factor in the formulation.

(b) The visual search algorithm is based on an assumption that search is conducted over the full 360^{o} circle, with emphasis along a primary axis of observation. Although this assumption may be a reasonable general approximation for attacking weapons, it was clearly invalid for the defending weapons of the TETAM experiment. The basic problem is that the procedure for determining where a search is concentrated does not consider limitations on the field of view forced by either tactical considerations or physical blockages. In the field experiment, for example, it would have been impossible for many of the defender weapons to detect anything to their rear because their backs were to distinct terrain features. In fact, frequent instances were noted where a defender's fan of observation was blocked to well under 90^{o}.

(c) The assumption of a search sector is cancelled out for a target about which the observer has general area knowledge. In this case, the model assumes that the observer will look in the target's area. Since general area knowledge never deteriorates, this assumption holds true regardless of how long it has been since the target was seen and regardless of how far the target may have displaced. Additionally, as a battle progresses and this general area knowledge of individual targets builds up, the individual observer is portrayed as scanning the correct sectors for more and more targets with no time limitation.

(d) When the two treatments of search sectors discussed above are considered jointly, it appears that the model may understate detections in the early stages of a battle because of overly dispersed search sectors and may overstate detections as the volume of general area intelligence builds up. This problem is potentially serious in a situation with large forces.

(2) Firing cue detections. The assumption is made in DYNTACS that weapons firing is such a distinctive cue that any unconcealed weapon that fires will be detected immediately by all observers who have a clear line of sight to that weapon. The TETAM field experiment indicates that this is an invalid assumption.

(3) Intensive area search. The assumption is made in DYNTACS that upon detecting or firing at a target a weapon's crew, by virtue of concentrating its attention in the target area, will detect all other detectable targets in that area. There are two significant problems with portrayal of this type detection.

(a) The size of the immediate area about the original target is required as input data. Since there is a lack of empirical data of this type, the data used must be subjective. Given a sufficient body of data, the model would probably have to be expanded to consider crew size and the optical field of view of devices used to search this near area.

(b) The intensive area search will take some time and concentrated effort on the part of the weapon crew, thus temporarily detracting from their ability to detect in other areas. This detraction is accomplished on completion of an intensive area search by disallowing, for the duration of the model observer's current event, any further random detections of targets previously unknown to the observer. This representation is inadequate for several reasons. First, duration of a current event is an arbitrary period of time. Second, detection of any target by firing cues and of targets for which the observer has general area knowledge by random search progresses unimpeded. Thus, in the early stages of a battle, with relatively low firing levels and general area intelligence levels, the intensive area search may prevent a number of potential detections. However, as the battle progresses and the levels of firing and particularly levels of general area knowledge build up, intensive area searches will have a progressively lesser impact on ability to detect other targets.

(4) Pinpoint detections. Pinpoint detections are accomplished when a crew lays its weapon on the firing signature of a target but has no clear visual picture of the target because of concealment. With the revised treatment of the environment used for TETAM (discussed in paragraph 7-2b) the associated concealment concept required for this type detection was lost. Thus, for the TETAM investigation, the ability to portray pinpoint detections was sacrificed to attain a more coherent environmental representation.

e. Tactical Movements. Tactical movements are portrayed through the movement controller and the movement modules of DYNTACS. These modules are generally well conceived and implemented. Certain shortcomings and areas for improvement exist.

(1) The level of information available to a maneuver unit leader appears to be excessive.

(2) The strict adherence to geometrically patterned formations embodied in the model is contradicted by behavior in the field experiment. Individual weapons should have greater flexibility to take advantage of local cover and concealment. The model adherence to formations also implies a degree of control (or effective battle drill) that was lacking in the field experiment.

(3) There is no apparent way to portray local chokepoints such as river fords or road embankments.

(4) The mobility representation is so highly detailed that it is out of balance with the rest of the model.

f. Firing Sequence. The general representation of weapons firing sequences in DYNTACS appears to be satisfactory except for treatment of target selection or assignment. Additionally, as noted in the next paragraph, incorporation into the event sequencing logic is faulty.

(1) The level of intelligence assumed available for target selection is excessive.

(2) The target prioritization algorithm used for target selection is obscure. The typical model user would have difficulty in providing input data that would clearly portray his intentions.

(3) There is no opening engagement logic, nor is there any mechanism to portray reconnaissance by fire, firing at suspected target locations, or suppressive fires.

g. Additional Problems.

(1) Event sequencing. The event sequencing logic of DYNTACS is particularly weak in the time-phasing of intelligence and related activities. Additionally, sequencing of the firing and assessment logic can allow "dead" weapons to fire. In general, the definition and phasing of events throughout the model is questionable.

(2) Individual and crew performance. The individuals and crews simulated in DYNTACS perform their roles noticeably better than those in the field experiment. This is a reflection of the inability of models to consider the state of training and morale of individuals. However, in the experiment, attacker performance broke down to a greater extent than did defender performance. This indicates that for the attacker, who has to move, one activity, such as picking a route and moving, may degrade another, such as finding targets. Generally, models do not consider this kind of interaction between activities. Rather, each action is viewed as an independent event.

7-3. DYNTACS CONCLUSIONS.

a. The basic ground weapon modules of DYNTACS, with intervisibility and detection modifications made for TETAM, produce a credible portrayal of the type battles considered in Experiment 11.8 both in terms of overall battle outcome and in terms of the general development of the battle.

b. The major weaknesses of DYNTACS are in its event sequencing logic and in its intelligence module.

(1) The event sequencing logic lacks sufficient resolution in definition of events and, consequently, sequences critical events poorly.

(2) The intelligence module is limited to explicit portrayal of target detections, with excessive levels of both friendly and enemy intelligence assumed for movement and fire control functions.

(3) Levels of knowledge about a target are poorly defined and poorly integrated within the model. In particular, the general area and pinpoint levels of knowledge lack clear definition; and general area knowledge never decays.

(4) Portrayal of detections by firing cues is based on an incorrect assumption and is invalid.

(5) Portrayal of an intensive area search is driven by subjective input and lacks proper accounting for time spent in this detection mode.

(6) Portrayal of general search areas is overly simplistic in that it lacks consideration of restricted fans of observation and can be driven by the definition of general area knowledge.

(7) The basic detection algorithm used in a general area search mode is derived from two disparate experiments.

c. Secondary weaknesses exist in the firing module in that there is no opening fire logic or mechanism to cause reconnaissance by fire, firing at suspected target positions, or suppressive fire. Additionally, the definition of target priorities is overly complicated.

d. Secondary weaknesses also exist in the movement model in the strict geometric interpretation of tactical formations and in the inability to portray local chokepoints to movement.

7-4. RECOMMENDED DYNTACS IMPROVEMENTS.

a. Priority I. The following changes to DYNTACS were demonstrated to be appropriate and should be implemented immediately.

(1) The detection of a weapon by firing cues should be treated as a random rather than an assured process, which is a simple logic change. Reasonable estimates of the probability of such detections should be obtained from the TETAM experimental data, pending a more cohesive experimental investigation of detection.

(2) A stochastic treatment of vegetation, similar to that used in TETAM, should be incorporated into the model. The TETAM modification was preliminary in nature, and a treatment should be developed that fits more clearly into the overall model logic.

b. Priority II. A less confusing target selection scheme should be developed to insure that the user's intentions are reflected meaningfully.

c. Priority III. The following areas of improvement have a high priority because of their serious impact on model validity; however, they imply substantial resource expenditures.

(1) The entire intelligence module should be reviewed and improved. Controlled experimentation is indicated in many areas, for example, better definition of the area of intensive search, better definition of overall search patterns, time required for an intensive area search, discrimination of areas where detection is possible but weapon firing may be impossible, the impact of general area knowledge on search patterns and deterioration of such knowledge, pinpoint detections as a distinct entity, and the existence of false targets.

(2) The incorporation of intelligence with the event sequenced logic should be reviewed in an attempt to make intelligence track more closely with intervisibility and to represent more clearly the time relationship between detection and target selection.

(3) The event sequencing logic should be revised to allow greater resolution and definition of distinct events; for example, an appropriately timed round impact event would remedy the firings by dead weapons noted in the TETAM runs.

d. Priority IV. The following areas should be considered for modification. They would contribute to improved validity; but they are substantial model expansions, and the benefit derived might be outweighed by resources required and increased model complexity.

(1) The communications model should be expanded to carry meaningful tactical traffic and permit consideration of the implications of communications on tactics.

(2) The movement model should be revised to allow individual elements some leeway within prescribed formation to take advantage of local cover or concealment.

(3) The movement model should be expanded to allow portrayal of chokepoints, such as river fords.

(4) The firing module should be expanded to permit firing at suspected locations, reconnaissance by fire, and suppressive fires.

7-5. IUA FINDINGS. In the following discussion of IUA findings, reference is made to "standard data." In the original development and application of IUA (for the TATAWS study) an exhaustive data base was produced. Many areas of the model are programmed at a high level of generality, depending on input data to provide specificity on such details as forms of distributions from which to sample. Ensuing applications have relied heavily on the original data base for this information. Thus, for typical applications of IUA, the program logic as elaborated by the "standard data" constituted the model that is used and the model that was investigated for TETAM.

a. Battle Outcomes. Overall outcomes of the two field trials were consistent with IUA results except for excessive model kills of the attacker ICVs. Consistency in Trial 34, however, was attained only after downward adjustment of defender firing rate data.

(1) The tendency of model defenders to engage and kill unarmed threat ICVs at a higher level than was noted in the field is not detrimental to ability to kill other targets. The ICVs were essentially ignored in the field.

(2) Trial 34 was a one-sided battle. The excessive rate of activity, which required adjustment in Trial 34 for agreement with field results, was also present in Trial 96. Trial 96, however, was a more even two-sided battle, and excessive activity rates on both sides tended to cancel out insofar as overall battle outcome was concerned.

(3) Arrival at the nominally "correct" battle outcome through compensating errors, such as excessive activity rates on both sides tending to cancel, may be the standard behavior of IUA. It is questionable that the same battle was represented in the model runs and the field trial.

b. Intervisibility and the Associated Environment.

(1) The major shortcoming of IUA's portrayal of intervisibility is its extreme oversimplification. The invalid assumption that all defenders in a given area have identical intervisibility was corrected for TETAM. An equally gross simplification is made for attackers, whereby all vehicles associated with a route (up to six) have the same intervisibility as they pass a given point on the route. This representation accounted for almost half of the firing inconsistencies between the field and the model. Additional oversimplifications in areas of the model not used for TETAM are the assumption that attack overwatch weapons or defenders, when moving, are fully masked from the enemy and that overwatch weapons have intervisibility to all defenders.

(2) Concealment in IUA is input as a descriptor of attack routes. This representation has several shortcomings. Since vegetation is accounted for both within the terrain data and by this means, there is a lack of coherent treatment. Concealment is treated as blocking to random detections but as not hindering detection of firing cues or of firing. This treatment does not allow for portrayal of regions of intermittent visibility such as that in which the field trial took place. Further, it is one-sided in that it affects only a weapon's detectability and not its detection capability. Half to two-thirds of the

firing inconsistencies noted in the TETAM runs could be traced to the model's treatment of concealment.

c. Target Detection and Intelligence. Explicit portrayal of intelligence in IUA is limited to target detections. Where movement and fire control decisions imply knowledge beyond that gained by individual detections, the needed information is assumed avaible.

(1) Target detections are represented through algorithms to portray the detection of firing weapons and of nonfiring weapons. The algorithm for detection of firing weapons is probabilistically incorrect since it uses a single independent event formulation upon firing of individual rounds yet treats these rounds in a cumulative manner. An alternative formulation does not contain this error but introduces an inadequately defined adjustment factor. The algorithm for detection of nonfiring targets includes a two-step Monte Carlo determination, first, of whether a detection occurs and, second, of detection time. This formulation is unsound because of logical redundancy. Additionally, both determinations depend upon input data for which no satisfactory definition has been found.

(2) Both detection algorithms are made to apply, with the same data, to detections by and of individual defender or attack overwatch weapons and to detections by and of attack maneuver sections composed of one, two, or three weapons. The aggregation to sections is incorrect.

(3) Once a target has been detected it remains detected throughout the battle. A target may be unengageable for some period of time due to loss of intervisibility, but once intervisibility is reestablished, regardless of how long the target has been masked or how far it may have moved, it is instantly redetected and engageable.

d. Movement. Explicit portrayal of movement in IUA is limited to the movements of attack maneuver sections. Movement of these sections is assumed to take place at the maximum vehicle speeds possible in the terrain being used. Movement paths are determined by the model user. All movement is deterministically scheduled by a movement preprocessor and is independent of the dynamics of the situation. In addition, the movement of attack overwatch and defender weapons is artificial and not explicitly portrayed.

(1) Results of the TETAM field experiment contradict the assumption that vehicles move at their maximum capabilities.

(2) Aside from a stereotyped treatment of fire and movement, as conducted by two sections on a given advance route, there is no meaningful portrayal of tactical maneuver in the model. There is an attempt to coordinate movement between routes, but it is independent of the dynamics of the battles and can lead to such actions as having several sections hold at a phase line until other sections, which already have been killed in the battle, would have reached the line according to the

precalculated movement schedule. In the same vein, fire and movement bounds will be conducted by one section as scheduled even if its companion section has been killed.

e. Firing Sequence.

(1) Target selection in IUA is driven by a simple priority scheme. Considering the general level of representation in the model, this scheme is adequate.

(2) The calculation of time delays associated with firing in IUA is straightforward; however, it requires input data undefined in available model documentation. The typical user would probably rely on the available "standard data" without appreciating its significance. Time delays are poorly applied. In particular, when "standard data" are used, the model shifts fire to a new target much more rapidly than it fires subsequent rounds at an original target.

(3) Firepower only kills for all weapons and mobility only kills for attackers are treated as total kills in that a weapon suffering such partial kills is removed from the battle.

(4) For vehicles that must stop to fire, firing may only take place from positions specified by the user.

7-6. IUA CONCLUSIONS.

a. IUA is capable of developing the same general outcomes seen in the Experiment 11.8 trials investigated. The dynamic development of the IUA battles, however, is not similar to the field battles.

b. The greatest weaknesses of IUA lie in its inability to deal with the dynamics of a battle, its extreme oversimplification of tactical movement, and its aggregated treatment of maneuver weapons.

c. The treatment of intelligence in IUA contains probabilistically incorrect formulation in each target detection algorithm found in the model and is based on a series of invalid or questionable assumptions.

d. Application of delays associated with firings in IUA are incorrect, and the data generally used to calculate such delays are contradicted by field experiment results.

e. IUA data requirements, particularly those involved in detection and in firing delay computations, are inadequately documented to permit valid data development.

f. The applicability of IUA is limited to gross firepower comparisons of relatively small ground weapon forces.

7-7. IUA RECOMMENDATIONS.

a. General. Many of the shortcomings of IUA are limitations rising from the overall design of the model. The use of a deterministic preprocessor to schedule all movement and major tactical decisions prior to actual simulation of the battle mitigates against dynamic portrayal of movement or tactics, which, in turn, implies that IUA cannot, without total redesign, be a reasonable tool for any applications except the gross comparison of force firepowers. The various lesser modifications recommended below will allow the use of IUA as a gross firepower comparison tool, with improved assurance that results are reasonable, but will not support use of the model for more detailed investigation.

b. Recommended Modifications.

(1) Priority I. The following simple changes to the IUA intelligence logic are recommended to correct inconsistencies.

(a) The cumulative treatment of firings in the algorithm to determine detection of firing weapons should be removed.

(b) The redundant probabilistic treatment of detection of nonfiring weapons should be corrected by removing the original determination of whether a target is detected.

(c) Intelligence of a target should be allowed to deteriorate, calling for redetection, after line of sight to the target has been interrupted for a significant amount of time. Definition of significance must be subjective.

(2) Priority II. Portrayal of the firing sequence should be redefined to incorporate a reasonable delay upon selection of a new target after defeat of or upon shifting from an original target.

(3) Priority III. As a follow-on to the Priority I changes listed above, research should be conducted to establish a detection time distribution adequately keyed to pertinent target parameters, such as size, and to establish in objective terms a period of lost intervisibility after which redetection will be required.

(4) Priority IV. The generally used data base, particularly in the area of delay times, should be reviewed in light of the TETAM experiment as a first step to developing more reasonable data. Follow-on controlled experimentation will also be required to substantiate most of these data.

(5) Priority V. Further research on the movement of vehicles in a tactical situation is required. TETAM results indicate that the IUA assumption of movement at maximum speeds is invalid, but the results do not provide a sufficient basis for development of alternative treatments of movement.

(6) Priority VI. These changes approach drastic restructure of the model and should be undertaken only after due consideration of the potential benefit in light of resource requirements.

(a) Aggregated treatment of maneuver sections should be replaced by treatment of individual weapons. This modification implies incorporation of a meaningful tactical formation within the section and individual treatment of intervisibility.

(b) Appropriate treatment of weapons suffering mobility only and firepower only kills as continuing targets and potential firers should be added. This modification involves restructure of the interface with scheduled movement as well as the disaggregation of sections called for above.

(c) A means should be developed to incorporate all terrain characteristics into the model terrain portrayal rather than allowing the developer of tactical input to specify concealment and soil characteristics along the route.

c. Additional Recommendations.

(1) The logic for portrayal of overwatch weapons and movement of defenders should not be used. These movements should be portrayed explicitly or, for overwatch weapons, through delaying barriers as was done for TETAM. Development of explicit movement logic is of questionable value when the inability to portray dynamic tactics is considered, and an inability to move defenders might well be accepted as a basic model limitation.

(2) Use of IUA preprocessors to support other models should be a subject of critical review. These preprocessors have been used in coordination with more sophisticated treatments of firepower, such as in Bonder IUA, to provide tactical credibility. Considering the invalid movement rates, aggregated treatment of maneuver sections, and sterile tactics of the preprocessors, such applications may be patently incorrect.

APPENDIX A

MODEL INPUT IDENTIFICATION AND SPECIFICATION

APPENDIX A

MODEL INPUT IDENTIFICATION AND SPECIFICATION

A-1. PURPOSE. This appendix contains an identification and discussion of input data elements required by the DYNTACS and IUA models. Information is limited to the basic ground combat portions of these models used for the TETAM Model Verification Study. The appendix was produced to provide the reader an appreciation of the data development effort required to operate the models and as an aid to future users of these models.

A-2. ORGANIZATION. Annex A-I describes data requirements for DYNTACS, and Annex A-II contains analogous information for IUA.

ANNEX A-I

IDENTIFICATION AND SPECIFICATION OF DYNTACS INPUTS

1. PURPOSE. The purpose of this annex is as follows:

a. To report the results of research performed in identifying the input data requirements of the DYNTACS model and the principal uses of each of these data elements within the model.

b. To outline the approach taken in attempting to specify suitable values for each of these inputs so that meaningful comparisons between model and field trial response data could be made.

2. SCOPE. The input data described in this annex are comprehensive only in the sense that all data required by DYNTACS in simulating the activities of Subphases IIIB and IIIE of CDEC Experiment 11.8 are described. Only tank and antitank missile weapons were included in the IIIB and IIIE field trials; no play of automatic weapons, hand-held antitank rockets, minefields, indirect fire support, attack helicopter operations, air defense operations, or tactical air support was included. All the trials of these two subphases were conducted during daylight hours and under conditions of good visibility. Although DYNTACS possesses substantial capabilities with respect to several of these other aspects of combat, no attempt was made to include descriptions of model inputs other than those required for the Subphase IIIB and IIIE scenarios. No attempt was made to include descriptions of the approximately 175 working arrays for which computer storage must be allocated through input data, since these variables require no substantive input data.

3. CONTENTS. The model inputs are grouped into three functional categories: (1) Definition of Battle Entities, (2) Tactical Scenario Data, and (3) Weapon System Performance Data. Various subcategories are established within each of these major groupings, with a table being devoted to all input data applicable to each subcategory.

4. APPLICABILITY. The information contained in this document describes applicable portions of the DYNTACS(X) model as improved by the DYNTACS Task Force supporting the HELLFIRE Cost and Operational Effectiveness Analysis (1975). This version of the model contains a substantial number of improvements not present in earlier model versions. In general, the "Base 4" edition of this version was used for the DYNTACS work, although selected changes from later editions were incorporated as they emerged from the DYNTACS Task Force when they seemed to represent obvious improvements to the basic ground game. For example, an improved scheme for establishing target priorities and a change establishing

positive control through input of the amount of cover available to defender weapons were both integrated prior to production model runs. Thus, some of the information contained here represents a significant departure from descriptions found in the model documentation published during the period 1968-1971.

5. REFERENCE. This document does not include the actual numerical values specified as input for these field trial scenarios or a detailed description of the necessary model modifications. This detailed information is on file in the Combat Operations Analysis Directorate of the Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas.

6. INPUT DATA TABLES. The tables included in this annex are listed below for easy reference.

Table A-I-1. Identification of Battle Entities

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
LWCOD	The DYNTACS *Weapon Code*. A numerical code used to designate each element as a particular type of weapon system (e.g., M60A1).	Used extensively throughout simulation in identifying performance data and tactics appropriate to each element.	Assigned arbitrarily. Classified once assigned.
LWSYS	The DYNTACS *Weapon System Code*. An additional numerical code that can be used to group weapon system types into larger categories (i.e., tanks, APCs, etc.).	Certain data related to firing tactics are specified for the various *weapon system codes*. See Table A-I-2h.	Not used. (LWSYS and LWCOD initialized identically.)
LMO3T	The DYNTACS *Mobility Code*. A numerical code used to designate each element as a particular mobility system type (e.g. M113).	Used to identify the set of mobility input parameters applicable to each element. See Table A-I-3g.	Mobility data for the weapon systems actually used in the field trials were input (M60 data used for threat tank, etc.).
LFUNC	The DYNTACS *Function Code*. A numerical code used to identify launchers and FO's.	See description.	Not used. (Set to 0)

Table A-I-2a. Tactical Scenario Data - Tactical Situation at Battle Outset (continued next page)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
MISION	Assigned Mission. Specifies the type of mission assigned to each *maneuver unit*. Missions include attack, delay, overwatch, fire support, etc.	*Maneuver units* assigned different missions are processed differently during the simulation. The mission code is used to identify applicable model logic.	As appropriate.
ELOCX ELOCY	Initial *Element* Locations. The X and Y coordinates of each *element* at the outset of the battle. (Note: A special DYNTACS rectangular coordinate system is used. All model inputs, internal computations, and outputs use this coordinate system.)	The model maintains accurate current locations for each *element*, and these data are used extensively throughout the simulation (e.g., in evaluating LOS, engagement ranges, etc.). It should be noted that specific field locations such as defensive positions are often difficult to convert exactly into the model's coordinate system, and alternate placement methods should be used.	Initial attacker locations were extracted from Appendix D. Defenders emplaced within 100 meters of their field trial locations. Exact locations used were those providing observation consistent with PhIA and TETAM Extended Analysis data.
EMICR	*Microterrain Deviation*. Each *element's* deviation from the *macroterrain* surface at the battle's outset must be specified. (A recent model change permits the user to specify the amount of cover desired when emplacing stationary elements.)	The model computes each *element's* elevation as the sum of the *macroterrain elevation* at the *element's* location plus a random *microterrain deviation*. Thus, *microterrain deviation* affects both the cover available to an element and its fields of fire. A new deviation is computed each time an element moves.	*Microterrain deviations* for defender positions were set so as to provide the degree of cover outlined in the defensive position analysis (Appendix D). If the defender's observation was affected, observation took precedence.
NCAMO	Camouflage Flag. Specifies whether or not each *element* is camouflaged.	*Detection rates* for camouflaged elements are lower than those for uncamouflaged elements. (The *detection rate* is multiplied by a constant factor (.704) when computing detection probabilities.)	Elements reported as camouflaged in the defensive position analysis were flagged (Appendix D).

Table A-I-2a. Tactical Scenario Data - Tactical Situation at Battle Outset (concluded)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
EDIR	Current Heading. Each *element's* initial direction of movement is specified at battle outset. Headings for moving elements are updated during execution.	Each *element's* current heading establishes the center of its sector of fire. The current heading of each *maneuver unit leader* is also used to compute each subordinate element's *principal observation direction* an important variable in determining detection probabilities (Table A-I-2g). The input value of EDIR is used as the *principal observation direction* for defenders.	For attackers, set to approximate direction of movement at battle outset. For defenders, set using LOS maps to center of mass of LOS in zone.
LAMMO	Initial Ammunition Supply. Specifies the on-vehicle (or on-individual) basic load by round type for each *element* at battle outset.	The model keeps track of ammunition expenditures for each *element* by round type. When an *element* expends all of its ammunition, it simply stops firing. *Elements* make no effort to conserve ammunition as supplies are depleted.	Values input correspond to the ammunition basic loads used throughout the field trials.
DIRMU	Desired Movement Direction. The initial *desired movement direction* for each maneuver unit.	Values are only used at battle outset and only if the model-user allows the model to specify initial locations for elements other than maneuver unit leaders.	Approximate directions of movement based on the field trial analyses were specified.
LDPC	Desired Position Flag. Specifies whether each *element* is stationary or moving at battle outset.	This is one of the flags used throughout the simulation for coordinating movement and direct fires. It has no particular model implications.	All defenders stationary; all attackers moving.
ECONR	Distance to Nearest Concealing Vegetation Clump.	Not used in TETAM version.	

Table A-I-2b. Tactical Scenario Data - Intelligence Available at Battle Outset

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
BLUDET REDDET	Detection Status. These arrays specify each element's *state of knowledge* with respect to each enemy element. Four states of knowledge are provided for: (1) *no knowledge*, (2) *general knowledge* (enemy element's approximate location is known), (3) *full knowledge* (enemy element's exact location and weapon type are known), and (4) *pinpoint* (a fully concealed enemy element's location and weapon type are known from its firing signature).*	Only the *full knowledge* and *pinpoint* states provide sufficient intelligence to permit engagement of a target by direct fire weapons. However, if *general knowledge* of the target exists, the likelihood of obtaining *full knowledge* is improved significantly (Table A-I-3b).	Where the field trial analyses indicate that substantial pre-trial knowledge probably existed, the attackers were specified as having *general knowledge* of selected defensive positions from the battle's outset.
EW	Estimated *Effective Ranges*. The red and blue commanders' estimates of the *effective ranges* of each enemy weapon type at battle outset.	These ranges are used during route selection to determine whether detected enemy weapons are close enough to the maneuvering unit to affect its choice of routes. Thus, the term *weapon effective range* is somewhat misleading.	The ranges at which attacker movement began to exhibit respect for defender capabilities for observation and fire were estimated based on field trial analysis.
S T	Enemy *Strongpoint* Locations. The coordinates of those suspected enemy locations to be given special consideration when selecting routes for tactical movement.	These potential enemy *strongpoints* are considered by maneuver units during route selection along with enemy weapons actually detected. As *strongpoints* are only suspected enemy locations, actual weapon types at *strongpoints* (if any) are unknown. Thus, the ranges of weapon types likely to be at *strongpoints* are used to determine whether the *strongpoints* should influence the unit's maneuver. Once the *maneuver unit* closes within *assault range* of its current objective (Table A-I-2i), *strongpoints* are ignored.	Where the field trial analyses indicated that the attacking force was especially watchful for weapons at frequently used defensive positions, these positions were designated as *strongpoints*, provided that they were not occupied. When these positions were occupied, the attackers were given *general knowledge* from battle outset, and the positions were not treated as *strongpoints* to prevent double weighting.
ET SPTS	Enemy Strength at *Strongpoints*. Red and blue commanders' estimates of the weapon type and effective ranges of weapons likely to be encountered at enemy *strongpoints*.		

*Additional knowledge states for detections of helicopter elements and for detections by laser detection devices exist but are not applicable to TETAM.

Table A-I-2c. Tactical Scenario Data - Organization for Combat

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
MANORG MANLDR MANTYP LMANU ITPAR	Identification of *Maneuver Units*. A *maneuver unit* is a section, platoon, or team organization that maneuvers as an independent entity along a prescribed axis of advance toward an assigned objective or series of objectives. Any combination of sections, platoons, and teams in a force can be designated as *maneuver units*. One *element* in each *maneuver unit* is designated the *maneuver unit leader*.	The exact route to be followed by a *maneuver unit leader* is determined dynamically within the model based on the unfolding tactical situation. The routes to be followed by all other elements within the *maneuver unit* are determined by their assigned position in an appropriate tactical formation (itself dynamically selected from a number of formation patterns specified by input) centered on the *maneuver unit leader*. (Note: The term *maneuver unit* denotes a capability for independent maneuver; it does not imply an additional echelon.)	As no record was kept of the actual task organization in effect during each field trial, one of the specific objectives of the field trial analyses was to deduce these organizational structures from available data. It is likely that the task organizations that resulted are not the actual structures used in the field. These organizations are, however, descriptive of the maneuver plans as they unfolded. Separate task organizations were identified for each trial and are reported in Appendix D.
LSEC LPOS ISORG	Section Organizations. Specifies the *elements* comprising each section and assigns *position numbers* to the elements within each section. Sections contain from 1 to 4 *elements*.	In most respects, the individual *element* is the fundamental entity in DYNTACS. However, any moving *element* that halts in a stationary firing position forces all *elements* in his section to halt. Also, the problem of distribution of fires is treated at the section level. The *position numbers* assigned to each *element* (1) are used to assign each element a place in section formations and (2) imply a scheme for succession to command.	
ISPAR ISPOS IPORG	Platoon Organizations. Designates the sections comprising each platoon and assigns *position numbers* to the sections within each platoon. Platoons contain either 1 or 2 sections. The section to which the *maneuver unit leader* is assigned is called the *lead section*. Sections designated as *maneuver units* are not assigned to a platoon and are treated as *lead sections*.	*Lead sections* are not permitted to stop to fire until they close within an input *assault range* of their objective (Table A-I-2i). Each section's *position number* is used to establish the section leader's location in platoon formations and implies a scheme for succession to command.	
IPPAR IPPOS ITORG	Team (Company) Organizations. Designates the platoons comprising each team and assigns *position numbers* to the platoons within each team. Teams contain from 1 to 7 platoons. Sections and platoons designated as *maneuver units* are not assigned to a team.	Each platoon's *position number* is used to establish the platoon leader's location in the various team formations and implies a scheme for succession to command within the team.	Team organizations were not used. Their use would have interjected a degree of centralized control over attacker movement that did not exist during the field trials and would have seriously reduced realistic representation of dynamic route selection.

Table A-I-2d. Tactical Scenario Data - Attacker Scheme of Maneuver

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
NPTS XAXIS YAXIS	Objectives, Axes of Advance. The X and Y coordinates of all *primary* and *intermediate objectives* and the axes of advance for *maneuver units* are specified using the DYNTACS coordinate system.	The model's application of these control measures is similar to their use in actual operations. *Maneuver units* guide on their axes of advance but have considerable latitude in selecting their exact routes along those axes. *Intermediate objectives* are occupied only temporarily and do not delay the attacking unit. Each *maneuver unit* must seize its first *primary objective* before any unit attacks its next objective, however.	Extracted from the appropriate field trial descriptions (Appendix D).
NPHAS XPHAS YPHAS SPHAS	Phase Lines. The X and Y coordinates of the points at which each phase line crosses an axis of advance and the slope of the phase lines at each of these points are specified.	The use of phase lines is optional. When used, they serve to coordinate the movement of separate *maneuver units* by reducing speeds of the leading units so that all *maneuver units* cross phase lines at approximately the same time.	Attacker movement in the model was controlled through the use of phase lines to insure that model attacks followed the same time schedule as the respective field trials.
WPHAS SPDPHS	Crossing Phase Lines. The "speed limit" for a *maneuver unit* at a phase line (while waiting for the other *maneuver units* to reach the phase line) is specified and a width is assigned to the area known as the *phase line zone*.	The *phase line zone* is an area of width WPHAS that is adjacent to the *phase line* along its entire length and lies entirely on the friendly side. As each *maneuver unit leader* crosses the *phase line*, the input speed limit is used as an upper bound on the *maneuver unit's* speed until all other *maneuver units* have entered the *phase line zone*.	
XDP YDP	Rally Points. The X and Y coordinates of defensive positions to be occupied in the event the mission is aborted are specified for each axis of advance.	When one of the break criteria is exceeded, the attacker *maneuver unit* aborts the attack and heads for the defensive position associated with this axis. The battle is terminated when each *maneuver unit* reaches its next objective.	Aborting an attack was not allowed in the field. Hence, it was not allowed in the model

Table A-I-2e. Tactical Scenario Data - Maneuver by the Defensive Force

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
FTMDEL	Earliest Delayer Withdrawal Time. The earliest time that a delaying *maneuver unit* is permitted to withdraw from an assigned delay position is specified. Each *maneuver unit* can be assigned up to four successive delay positions, and separate times can be specified for each.	*Maneuver units* assigned to a delaying mission withdraw to their next assigned delay position when either this delayer withdrawal time is reached or the *delayer break point* criteria are exceeded (Table A-I-2d).	Not used.
DELTIM	Time Between Withdrawal of First, Second Echelons. The time delay between initiation of withdrawal by *maneuver units* assigned to the *first delay force* and those assigned to the *second delay force* is input for each specified delay position.	The model provides the capability to withdraw forces from a delay position in two echelons. The time of withdrawal of the *first delay force* is determined as explained above; the *second delay force* follows by the specified time interval.	Not used.
NOUTFG	Units at an *Outpost*. *Maneuver units* assigned a delaying mission can also be assigned to *outpost* duty. Each delaying *maneuver unit* assigned to *outpost* duty is flagged.	The only distinction between normal delaying units and those assigned to outposts is that less stringent withdrawal criteria apply for outposts. Force ratios used to establish break criteria for outposts are based on the local enemy situation at each outpost rather than the overall enemy situation facing the entire delaying force over a large front (See Table A-I-2d).	Not used.
AMOV	Subsequent Positions for Weapons. A recent model change permits the user to specify the exact defensive positions to be occupied by each element after withdrawing from an assigned outpost. The exact location, *microterrain deviation*, and *principal observation direction* of each position are specified	The discussion in Table A-I-2a indicates that special care is required in specifying defensive positions. The model's procedure for emplacing elements in good defensive positions following their withdrawal from outpost positions was inadequate. An interim correction suitable for use following withdrawal from the combat outpost has been implemented, but a more general fix applicable to the total requirement for simulating a force delaying from successive delay positions is still required.	Not used.

Table A-1-2f. Tactical Scenario Data - Selection of Routes for Tactical Movement (continued next page)

BACKGROUND INFORMATION ON DYNAMIC ROUTE SELECTION

Although the general scheme of maneuver to be executed by each *maneuver unit* is established by the unit's assigned objectives and axes of advance (see Table A-1-2d), the exact route it follows is determined dynamically in response to the unfolding tactical situation facing the unit. The route selection computation is essentially an evaluation of the relative suitability of a number of candidate routes over a limited planning horizon. It is initiated each time a *maneuver unit* reaches the last leg of its previously computed route, and it is also performed whenever the intelligence available to a *maneuver unit leader* becomes significantly different from that used in that unit's preceding route computation. When initiated, this computation (1) identifies a set of candidate routes that are consistent with the maneuver unit's current location and assigned mission, (2) estimates the difficulty of each candidate route with respect to the prevailing enemy situation as perceived by the maneuver unit leader, (3) estimates each candidate route's difficulty with respect to mobility factors, and (4) selects one relatively good route from among these candidates, applying a selection criterion appropriate to the current tactical situation.

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
RTKON RTSIZE MANEUV5	Movement Tactics. Two ranges, specified by input, control the tactics to be implemented during route selection. These ranges are the *objective assault range*, AP, and the range within which the most direct routes to the objective are to be used, CLOSE. A threshhold value (KTAC), used to identify when a *maneuver unit leader's* intelligence becomes significantly different from that used in his previous route computation, is also specified.	DYNTACS assumes that attacker movement to an objective is conducted in three distinct phases. In the first phase, the attacker seeks the most covered routes available to avoid unnecessary exposure to the enemy. Once the attacker closes to within AP meters of his objective, he begins making maximum use of his firepower by seeking routes that give good fields of fire (second phase). Finally, during the final assault, the attacker moves by the most direct route onto his objective (third phase). This final assault begins CLOSE meters from the objective.	When the attacker's intent appeared to be rapid movement, inputs specified that the attack would begin with Phase II. Otherwise, all three phases were exercised. Inputs were derived from the appropriate field trial analysis.

Table A-I-2f. Tactical Scenario Data - Selection of Routes for Tactical Movement (concluded)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
RTKON RTSIZE $MANEUV_5$	Identification of Candidate Routes. The model uses a square lattice of grid locations (12 rows long, with alternate rows comprised of 5 and 6 points) to identify candidate routes. Inputs define the size of the route selection grid, its placement with respect to the *maneuver unit leader*, and the widths of partially and fully deployed formations to be used by maneuver units.	During the route selection computation, this route selection grid is defined such that one point at the near end of the lattice coincides with the *maneuver unit leader's* current location and a point at the far end lies on his axis of advance in the direction of the objective. The model uses the lattice thus defined to identify a large number of alternative routings through the lattice, and these are the candidate routes. It appears that formation widths are used to identify the other points in the lattice to be considered in addition to the one occupied by the maneuver unit leader when evaluating the various routings.	The various parameters defining the size and use of the route selection grid were developed from the field trial analyses. The intent was to provide maneuver unit leaders with latitude in selecting their routes comparable to that in the field trials.
ESM SCAP ESMP	Difficulty Due to Enemy Situation. Numerical measures of the relative threat posed to a maneuvering unit when within *effective range* of each enemy weapon type and each enemy *strongpoint* are specified by input. Two sets of values, called *difficulty increments*, are specified for each enemy weapon type: one set applies to maneuvering units outside *objective assault range*, the other set inside this range. Only one set of *difficulty increments* applicable to *strongpoints* is specified, and this set only applies to maneuvering units outside of *objective assault range*.	Two basic factors are considered in evaluating the suitability of a candidate route: (1) the degree of exposure to enemy weapons (and minefields) along the route and (2) the estimated travel time required to traverse the candidate route. The *difficulty* at any point in the grid is the sum of the *difficulty increments* of all enemy weapons and *strongpoints* that are within *effective range* of and are intervisible with the point. Only enemy weapons of which the *maneuver unit leader* has knowledge are included. The *difficulty* of a candidate route is the sum of the difficulties of all points occupied by the *maneuver unit* while traversing the route.	When the attacker appeared to regard rapid movement as paramount (as in Trial 34), these values were set to zero, thus forcing model attackers along paths yielding the shortest movement times. Otherwise, data that provided slightly greater weight to long range weapons than short and slightly greater weight to detected enemy than suspected enemy weapons were input.
TMEKON $MOVPAR_9$	Difficulty Due to Mobility Factors. *Difficulty* of each candidate route with respect to mobility factors is estimated using the terrain and mobility inputs (Table A-I-3a) and several related parameters that are specified by input in these common blocks. From these, the model computes the *expected travel time* required for traversing each candidate route.	The model uses the *expected travel time* as a measure of the length of time that this *enemy difficulty* persists by computing the *overall tactical difficulty* of each candidate route as the product of its expected travel time and its average difficulty due to enemy forces. A dynamic programming algorithm, using *overall tactical difficulty* as a measure of exposure, then selects a relatively unexposed route for units outside *objective assault range* and a relatively exposed route for units between objective assault range and final assault range.	These data establish certain limits on the mobility capabilities of moving elements. As the terrain at CDEC generally did not limit the movement of attackers, non-limiting values were specified for these parameters.

Table A-1-2g. Tactical Scenario Data - Unit Formations for Tactical Movement

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
FORMSX FORMSY FORMXS FORMYS	<u>Formation Patterns</u>. The various formation patterns to be used by the sections, platoons, and teams are specified by input. Each *element* is assigned a unique position in each of the various section formations, sections are assigned a position within each platoon formation type, etc. The spacing between elements, sections, etc. is also specified for each formation pattern.	The exact routes to be traversed by the *maneuver unit leaders* are computed by the route selection algorithm. Subordinate *elements* guide on their leader maintaining, insofar as possible, their specified distances from and orientation to the *maneuver unit leader*. The distance and orientation are defined by the formation patterns specified here. The *center of observation* is used to calculate each element's *principal observation direction*, a key detection parameter.	The formation patterns and spacings, formation speeds, and selection criteria observed in the field trials were input based on the analysis of each of the respective field trials. However, appropriate formation patterns and speeds are selected dynamically (from among those input) within the model based on emerging intelligence, so positive control of this facet was not established.
FORMAR IFNA	<u>Formation Selection Criteria</u>. Each moving *maneuver unit* periodically selects a suitable formation pattern based on the enemy situation, proximity to its next objective, and known minefields. The appropriate formation patterns for 10 predefined situations are specified by input for each unit type (lead section, trial section, platoon, and team).	Each time a *maneuver unit leader* becomes *current*, the suitability of his current formation pattern is reevaluated using updated intelligence and the proximity of the *maneuver unit* to its next objective. New formation patterns are identified when appropriate and implemented as each subordinate *element* becomes *current*.	
FSPEED	<u>Desired Formation Speed</u>. Desired speeds for red and blue formations moving in each of the 10 threat situations are specified.	The *maneuver unit leader* attempts to maintain this formation speed during movement. However, terrain conditions, lagging elements, occupation of *temporary firing positions*, phase lines, and other factors tend to reduce formation speeds realized.	
$MOVPAR_{10}$	<u>Allowable *Lag Distance*</u>. Moving *maneuver units* reduce speed when one or more *elements* in the unit start to fall behind. The maximum allowable *lag distance* (measured as the distance between the lagging element's actual and desired positions) is specified by input.	Whenever one or more *elements* in a moving *maneuver unit* fall farther behind their desired positions than this allowable *lag distance*, the *maneuver unit leader* reduces his desired speed. Depending on the actual lag distance, the maneuver unit's desired speed may be reduced by up to 50 percent.	

Table A-I-2h. Tactical Scenario Data - Fire Control Tactics and Techniques (continued next page)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
EMAX	Maximum *Cover Fraction*. The largest value the *cover fraction* (percent of a target's height covered) can assume without fires against the target becoming totally ineffective is specified for each target weapon type.	The application of these inputs, originally limited to selecting reasonably good firing positions for moving elements, has been expanded by recent model changes. In the current version of the model, targets covered more than the value specified in EMAX cannot be detected or engaged by direct fire weapons. Targets covered less than the specified EMIN value are treated as completely uncovered for target detection and selection; but in casualty assessment, the actual cover fraction is used to compute hit probabilities (although the aim point is not adjusted).	For the model runs, EMAX was set to 99 percent, EMIN to 1 percent.
EMIN	Minimum *Cover Fraction*. The value of a target's *cover fraction* below which reduced cover does not significantly improve firing effectiveness is specified for each target weapon type.		
DKR	*Desired Killing Ranges*. These inputs specify the maximum ranges at which target engagement is permitted. Separate values are specified for (1) moving and stationary firers, (2) each unique firer weapon type/ammo combination, and (3) each target weapon system type.	The model does not permit engagements to occur at ranges greater than these input values. (The terms *maximum engagement range* or *open fire range* would probably be more descriptive.)	Where the field trial analyses indicated that weapons were deliberately holding fire for one reason or another, these inputs were used to control fires. Otherwise, weapons were to open fire at maximum range.
RPRIOR IPRAMO	Ammunition Selection Criteria. Three range intervals are specified, and separate lists of ammunition priorities are developed for each. These lists specify the ammo priorities that apply to each firer weapon type against each target weapon type throughout the designated range interval.	When a firer finds a target, his highest priority ammo remaining in stock is selected for use. If he has no remaining ammo suitable for use against this target in this range interval, then the target is ignored. If he has a suitable round available, then the ammo type is used to determine whether it can be fired on the move or whether the firer's section must stop in a *temporary firing position*.	The cross-over range specified for the M551/Sheridan in the respective field trial analyses was input. The other systems had only one type available.

Table A-I-2h. Tactical Scenario Data - Fire Control Tactics and Techniques (concluded)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	•INPUT DATA SPECIFICATION
RATT RATE RACT RATF RATFCE RAAS	Target Selection Criteria. Several factors are considered in establishing target priorities when more than one target is available to a firer. These factors (called *range adjustment factors* in DYNTACS) include the target type, whether the target is being engaged by other friendly elements, whether the current firer is now engaging this target, whether the target is firing, whether it is firing at the firer, and whether the target is in the firer's assigned sector.	These *range adjustment factors* define the relative importance of the various factors governing target selection using the concept of *adjusted range*. Using this concept, the importance of a tank at 2000 meters can be equated to that of, say, an APC at 1000 meters. Similarly, an adjustment to actual target ranges can be made to differentiate between targets inside and outside the firer's assigned sector. These adjustments are normalized and added to each target's actual *range*, and the target with the smallest *adjusted range* becomes the target of choice.	A set of range adjustment factors designed to reflect the general target priorities of the field trial were developed. These reflected different preferences between target types. Defenders were given preference for a current target, targets in sector, and firing enemy targets.
SECANG	Sectors of Fire. The half-width of the sectors of fire is provided as input. Only two values are specified: one applies to all blue elements and one to all red elements.	Sectors of fire are one consideration in establishing target priorities. Each element's sector of fire is centered on its *principal observation direction*, itself a function of the *maneuver unit leader's* direction of travel and observation responsibilities specified in the tactical formation data (Table A-I-2g). The relative importance of sectors of fire in establishing target priorities is determined by values input for the *range adjustment factors*.	An average sector of fire based on the defensive position analysis (Appendix D) was assigned to defenders in each trial. A seemingly reasonable but arbitrary value was assigned to attackers.
KRC	*Initial Round Count*. The number of rounds to be fired at an assigned (i.e., selected) target before reevaluating target priorities is specified for each firer weapon type against each target weapon system type.	The model keeps track of the number of rounds expended by a firer during each firing assignment. When the number of rounds expended exceeds the input value, the assignment is reevaluated. If the same target is then reassigned, the firing assignment is then reevaluated after every round.	Values descriptive of observed field trial behavior were developed for each trial and are reported in the field trial analyses (Appendix D).

Table A-I-2i. Tactical Scenario Data - Coordination of Movement and Direct Fires (continued next page)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
NOFLG RMVFR FIRSPD	Moving Fire Tactics. Maximum ranges for the use of fire-on-the-move tactics are specified for each firer weapon type-ammunition combination. A limiting speed is also established for each firer weapon type in each rough terrain classification.	In DYNTACS, moving elements operate in one of two modes when firing: they either fire while moving or they stop to fire (in a *temporary firing position*). The appropriate mode is determined by the ammunition selected for use against the firer's assigned target. If the target is within the maximum range specified for fire-on-the-move by the firer's weapon and ammunition type (Table A-I-2h), the firer slows to the appropriate limiting speed (if necessary) and fires. Otherwise, the firer's section is directed to a *temporary firing position*. (NOTE: A third mode was added by a recent model change. In this mode, a moving element fires a first round in the process of moving into its temporary firing position, then follows up with another round from the halt.)	The TETAM field trial instrumentation is not capable of accurately recording moving fire data. In the field, steps were taken to prevent the use of this technique. Moving fire was not permitted in the model runs.
FIRCOM	*Assault Range*. The range (measured from an attacking element's current objective) outside of which the attacking force attempts to allocate only one firer to each enemy target is specified by a single input value. (NOTE: *Assault range* is not the same as *objective assault range* discussed in Table A-I-2f.)	The massing of fires by several attackers on a single enemy target is normally not permitted from outside of *assault range* in order to preserve the momentum of the attack. However, exceptions are made for elements in a section occupying a *temporary firing position*. In this case, massing of fires is permitted where necessary to realize the full firepower potential of the section while halted.	Attackers in the model were permitted to engage their highest priority target without regard to the activities of other firing attackers.

Table A-I-2i. Tactical Scenario Data - Coordination of Movement and Direct Fires (concluded)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
FIRCOM	*Assault Range for Elements in Lead Sections*. The range (measured from an attacking element's current objective) outside of which elements in *lead sections* will not stop (in *temporary firing positions*) to fire is specified by a single input value.	In order to maintain the momentum of the attack, elements in *lead sections* are restricted to the use of the fire-on-the-move tactic while outside *assault range for elements in lead sections*. Targets beyond the range criteria specified for this technique are not engaged by elements in *lead sections*, but an effort is made to hand these off to other firers.	Restrictive values were imposed where the field trial analyses indicated probable attacker intent to close rapidly for one reason or another.
$MOVPAR_2$	Formations in *Temporary Firing Positions*. The *threat situation* to be assumed by a section moving into a *temporary firing position* is specified (Table A-I-2g).	A section directed to a *temporary firing position* uses the tactical formation pattern appropriate to the threat situation specified here (Table A-I-2g).	Formations reported in the respective field trial analyses (Appendix D) were specified.
CONCOM	*Concealment Area* Parameters. The area within which a moving element intending to stop seeks concealment is called the *concealment area*. The size of this area and a second parameter defining its shape are specified by input.	Elements in a section moving into a *temporary firing position* that do not have targets are assumed to seek available concealment. The *concealment area* is used to determine the extent to which these elements succeed in finding it.	Both parameters were set to small values in order to circumvent this feature. As the Phase IA data describing type of mask was of questionable reliability, mask was generally treated as cover in the probabilistic LOS treatment implemented for TETAM.

Table A-I-2j. Tactical Scenario Data - Tactical Communications (continued next page)

BACKGROUND INFORMATION ON TACTICAL COMMUNICATIONS

DYNTACS simulates radio communications among elements on platoon, company, and battalion command nets and on various fire request nets. Three types of communications traffic are represented: *intelligence messages*, fire request messages, and *tactical messages*. Fire request messages are messages related to requests for and control of indirect fires. When an element detects an enemy element previously unknown to him, he disseminates this information by attempting to send an *intelligence message* on each net on which he maintains a station. All elements monitoring these nets that possess *no knowledge* (see Table A-I-2b) of this enemy element obtain *general knowledge* of that element from receipt of the *intelligence message*. The intelligence of an element possessing at least *general knowledge* of that enemy element is not affected by an *intelligence message* concerning that element. Elements possessing no previous knowledge of an enemy element prior to receiving an *intelligence message* attempt to retransmit this message on the other nets on which they maintain a station. However, *intelligence messages* may be either delayed or eventually discarded because of other traffic on the nets. *Tactical messages* are all messages other than *intelligence messages* and fire request messages. They do not simulate any explicit command or control activity. Their purpose is to provide realistic levels of all other communications traffic so that the effects of net saturation are represented.

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
MONLST	Communication Nets. The platoon, company, and battalion command nets and fire request nets are designated; and the red and blue elements that are stations on these nets are specified. Each station (i.e., element) on a net is designated as having either a send-and-receive or a monitor-only capability on that net.	These networks define the flow of intelligence and fire request information within each force. Stations with a monitor-only capability on a net can receive but not disseminate *intelligence messages* on that net. An element loses its communication capability only when its firepower capability is killed. These net organizations change as casualties occur. Suitable replacements are sought for elements that maintain stations on key command and fire request nets, and mobility kills are removed from their assigned nets and assigned to the battalion net.	As in the field trial, one radio net was allocated to each force. All defenders were allowed to send and receive. All attackers were allowed to receive; tanks and ATGMs were also allowed to transmit.

Table A-I-2j. Tactical Scenario Data - Tactical Communications (concluded)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
COMRAT	*Tactical Message Generation Rates*. The rate at which an element obtains (i.e., *generates*) information to be transmitted in *tactical messages* over its net(s) is specified (in messages per second). Separate rates are specified for each echelon (platoon, company, battalion) within both the red and blue force.	As indicated in the background material above, *tactical messages* complement *intelligence messages* in producing the total volume of radio traffic on each net. The model assumes a constant *generation rate* for a given net. Thus, the negative exponential distribution is used to generate *tactical message* at random times.	Based on comments of field trial observers, inputs intended to tie up the attacker net 75 percent of the time and defender net 25 percent of the time were specified.
MAXM	Message Retention. Two parameters are input describing the retention of messages not yet transmitted. These are (1) the maximum number of messages that any sender can accumulate for transmission while waiting for net time and (2) the maximum number of messages of all types that can be placed on the *message arrival list*.	Each sender is treated as maintaining a *sender queue* that contains all of the messages a sender would like to send but can't because his net is busy. It is assumed that only the most recent messages will be retained and any in excess of this maximum number of messages will be lost. The *message arrival list* is a bookkeeping device used by the model in managing communications traffic. It must be large enough to perform this function but has no modeling implications.	Each sender was permitted to remember an arbitrary maximum of three messages he was to send.
	Transmission Times. *Transmission* times are approximated by the gamma distribution with parameters α, β. Values for these two parameters are specified by input. This one distribution is used to generate the random *transmission* times for all nets.	When a sender obtains net time, he sends all of the messages in his *sender queue* without interruption. All of the *messages* accumulated in his queue are thus dispatched by a single *transmission*. The times required for these *transmissions* are generated randomly from the distribution described by input.	Transmission time data developed for use in the HELLFIRE COEA were prescribed due to non-availability of TETAM data.

Table A-I-3a. Weapon System Performance - General System Characteristics

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
TGTDIM	Frontal Dimensions. Eight key dimensions of the frontal aspect of each weapon type are specified. These include hull height and width, turret height and width, and location of the aim point used when the weapon is viewed as a target.	The heights of the various weapons are used as observer and target heights in the cover, concealment, and line-of-sight computations. The exposed (i.e., uncovered and unconcealed) frontal area presented by each element is computed periodically within the model and is used in the target detection computations, in determining correct placement of the aim point, and in determining hit probabilities.	Dimensions of the vehicle types actually used in the field trials were specified.
PKOV	Desired Depth of Defilade. The amount of a weapon's height for which cover is sought when in defilade is specified for each weapon type.	Moving elements that seek a *temporary firing position* attempt to achieve this desired amount of defilade when stopping. The amount of defilade actually achieved in the firing position is computed from the *frontage area* (see Table A-I-21) and the value of the *power spectral density* (see Table A-I-5a) applicable to the moving element's current location.	Values specified correspond to the vehicle types used in the field.
IHTPRB	System Armament. The armament on each weapon type is specified by identifying the various types of ammunition to be fired by each weapon type. Each combination of firer weapon type and ammunition is assigned an identification number.	Each of these combinations specifies a weapon capability that must be further described by detailed weapon-ammunition performance data. The simulation identifies the performance data applicable to a given combination by its identification number. These ID numbers are also used by the simulation in locating other stored data that are specified in terms of these firer weapon-ammo combinations. The other data include load and lay times, *desired killing ranges*, and *range adjustment factors*.	Same as field trial.
LDFR	Immediate Reload Capability. These input data specify whether a new round can be loaded immediately after firing for each weapon-ammunition combination.	If a particular ammo type can be loaded into the weapon immediately, the model starts the reload delay when the weapon fires. Otherwise, reload does not begin until projectile impact.	Same as field trial.
AMMOCH	Muzzle Velocity. Muzzle velocities are specified for each weapon-ammunition combination.	Muzzle velocities are used to compute projectile flight times.	Same as field trial.

Table A-I-3b. Weapon System Performance - Target Acquisition Capabilities (continued next page)

BACKGROUND INFORMATION ON TARGET ACQUISITION IN DYNTACS

General. Each element's knowledge of enemy elements at battle outset is established by input. Table A-I-2b explains that, at any instant, an element possesses one of four possible levels of knowledge with respect to each enemy element: *no knowledge*, *general knowledge*, *full knowledge*, or *pinpoint knowledge*. During any *event* for an element, that element's knowledge of each enemy element can increase, decrease, or remain unchanged.

Loss of Intelligence. Once an element obtains knowledge of any type with respect to an enemy element, it can never possess less than *general knowledge* of that element. However, when an element possesses either *full knowledge* or *pinpoint knowldege*, that intelligence is reduced to *general knowledge* whenever line of sight is broken and any time the element is *neutralized* (Table A-I-3c). *Pinpoint knowledge* is reduced to *general knowledge* when the observer fires and when he fails to engage the target within a suitable time period (two events).

Acquiring Intelligence. An element's intelligence increases (1) to *general knowledge* whenever it receives *intelligence messages* pertaining to enemy elements about which it previously had *no knowledge* (Table A-I-2j) and (2) to either *full knowledge* or *pinpoint* when it successfully detects hostile elements. There are four separate procedures by which detections are generated within DYNTACS, each being applicable to a particular target element situation. First, a target element that fires, and is at least partially uncovered and unconcealed with respect to the observer, is always detected immediately (*full knowledge*). Second, if a target element fires and it is fully concealed (but less than fully covered) with respect to the observer, a random number drawn from U(0,1) is compared to an input *probability of pinpoint* to determine whether detection occurs (*pinpoint*). The third procedure applies to targets that have not fired recently. The probability of detecting (*full knowledge*) each of these non-firing targets during the *current element's* previous event is computed from an equation of the form:

$$P_d = 1 - e^{-(\lambda)(\Delta t)}$$

where the parameter λ, representing the *detection rate* is itself a computed function of range, target crossing velocity, terrain scene complexity, camouflage, and observer speed. A recent model change added a new formula to compute λ, at the long ranges. The fourth procedure, the *intensive search* procedure, is initiated each time a detection results from any of the other procedures. An input rectangular area centered on the newly detected element is examined, and all elements within this *intensive search area* that are at least partially exposed to the observer are detected immediately (*full knowledge*).

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	DATA INPUT SPECIFICATION
INTELL	*Maximum Visibility Range*. The *maximum visibility range* is defined as the greatest range at which an observer could detect an enemy element given infinite search time and knowledge of the element's location. This parameter is specified by a single input value.	The value assigned for this parameter is important in two respects. First, no detections of any kind can occur in DYNTACS at ranges greater than the specified value. Second, a weapon that fires will always be detected immediately by every *intervisible* enemy element within this *maximum visibility range*. (Note: *Intervisible* implies that the firing weapon is at least partially uncovered and unconcealed with respect to a particular observer.)	Specified as 5 kilometers based on the detection analysis supporting the HELLFIRE COEA.

Table A-I-3b. Weapon System Performance - Target Acquisition Capabilities (concluded)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	DATA INPUT SPECIFICATION
INTELL	Probability of a *Pinpoint*. In DYNTACS, *pinpoint* is the act of acquiring a fully concealed target by aligning one's weapon sight on its firing signature. The probability that an observer, given intervisibility, will *pinpoint* a firing enemy element within two *events* after it fires is input as a single value.	The acquisition of an enemy weapon that fires and is fully concealed (but at least partially uncovered) with respect to the observer is treated using probabilistic methods. In evaluating each prospective *pinpoint*, a random number is drawn from U(0,1) and compared to the input probability. If the number is less than the probability, *pinpoint* occurs and a second computation is performed to determine whether the *pinpoint* occurs in the observer's *current event* or in his next event. An element cannot have more than one *pinpoint* at any given time.	Value set to p = .16 on same basis as above. Pinpoint detections were extremely rare in the model as set up for TETAM, however, due to concealment characteristics.
	Close Vicinity Search Area. The *close vicinity search area* is the area around a known target that is subjected to intensive visual search immediately following discovery of that target's presence. The dimensions of this *close vicinity search area* are specified by input.	DYNTACS assumes that whenever an observer detects a target he will perform an intensive search in that target's immediate vicinity for other enemy elements. Any *intervisible* enemy element located within the *close vicinity search area* is immediately detected by the observer. (Note: During any one *event*, the *current* observer is prevented from detecting elements about which he has no prior knowledge after the first *intensive search*.)	An appropriate value was established by evaluating the likelihood that defenders in the same vicinity would be detected together.
PFLRD	Threshhold for Long Range Detection. The range beyond which the long range equation is used to compute the *detection rate* for an enemy element is specified.	In determining whether the *current element* has detected the enemy elements that did not fire during that element's preceding event, DYNTACS computes the probability of detection from an equation of the form: $P(det) = 1 - e^{-(\lambda)(\Delta t)}$ If the range from the *current element* to the prospective target is less than this threshhold, the standard DYNTACS equation is used for computing the detection rate (λ) as a function of the *apparent range*, observer speed, target crossing velocity, terrain scene complexity, and target camouflage. If the threshhold is exceeded, a long range equation is used that computes λ as a function of these variables plus one additional factor, a weighting factor for observer optics.	Set to the values recommended in the detection analysis performed for the HELLFIRE COEA.
	Weighting Factors for System Optics. Values are assigned to a system optics weighting factor for each type of system to be simulated. These weights establish the relative detection potential of the systems due to their optics.		

Table A-I-3c. Weapon System Performance - Crew Performance (continued next page)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
ULD SIGLD	<u>Weapon Load Times</u>. The times required to load single shot (e.g., tank main gun) weapons are approximated by the log-normal distribution. Separate sets of the two parameters (μ, σ) that define this distribution are specified by input for each firer weapon-ammo combination. (Note: The model assumes that unless a weapon has fired recently, it has a round loaded and that round is the appropriate type for the <u>next</u> engagement.)	A random number is drawn from N(0,1) and the load time is then computed by: $t_{load} = \mu e^{(RN)\sigma}$. As a weapon may be loaded and aimed at the same time, the time delay from detection to trigger pull is the larger of load or lay time.	Same as played in the field trial software.
ULYN ULYNS SIGLYN	<u>First Round Weapon Lay Times</u>. The time delays required to achieve first round weapon lay are approximated by the log-normal distribution with parameters (μ,σ). Although σ is input directly, μ is not. Instead, two quantities from which μ can be computed as a function of range are input. A separate set of parameters are input defining the lay time distributions for each firer weapon-ammo combination.	The same procedure is used for computing a suitable lay time for both the first and subsequent round cases. It involves three basic steps: (1) The log-normal distribution parameter μ is computed by either: μ = ULYN+(ULYNS)(RANGE) or μ = ULY+(ULYS)(RANGE). (2) A random number is drawn from N (0,1). (3) The lay time is computed by $t_{lay} = \mu e^{(RN)\sigma}$.	Provided by AMSAA.
ULY ULYS SIGLY	<u>Subsequent Round Weapon Lay Times</u>. The time delays between round impact and trigger pull for a subsequent round are also approximated by the log-normal distribution with parameters (μ,σ). As in the first round case, separate distributions are defined for each firer weapon-ammo combination. Similarly, σ is input directly for each distribution but values describing μ as a function of range are specified.		
AMMOCH	<u>Round Sensing Probabilities</u>. Two probabilities are specified for each single shot (i.e., main gun) weapon-ammo combination. These are the probabilities that the impact of a round fired by a gun crew will be sensed (1) by the vehicle commander and (2) by the gunner.	Different dispersions are used in computing the probability of hit depending on whether the shot is fired (1) following a sensed hit, (2) following a sensed miss, or (3) following a "lost" round (See Table A-I-3e). The probabilities of sensing round impact are used to determine whether the round was sensed, and this determination is the basis for selecting the appropriate dispersions when a subsequent round is fired.	It was assumed that the subsequent round kill probabilities were used in the field whenever successive rounds were fired at the same target without moving. Thus, perfect sensing was specified.

Table A-I-3c. Weapon System Performance - Crew Performance (concluded)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
TMPRD	Rapid Fire Weapon Data. Two values are specified for each rapid fire weapon-ammo combination in each range interval. The first value specifies the time required to aim and fire the first round; the second specifies the time between successive rounds during *aim adjustment*.	The first value specifies the time delay between target detection and trigger pull; the second value is multiplied by the (computed) number of rounds required to achieve the first hit in order to determine the duration of the *aim adjustment event*.	Rapid fire weapons were not employed in either the field trials or the model runs.
TMISF	Time to Clear a Misfire. The time required to clear a misfire is specified for each single shot (i.e., main gun) firer weapon-ammunition combination.	Before each shot is fired, a random number is compared to the probability of a misfire to determine whether a misfire occurs (see Table A-I-3e). When a misfire does occur, the specified time delay is incurred for clearing the misfire.	Not used as no field trial analog existed.
TMNEUT	Length of *Neutralization Period*. In DYNTACS, *neutralization* is the temporary impairment of an element's ability to observe the battlefield that results from rounds impacting in the element's immediate vicinity. *Neutralization* occurs wherever an element experiences a near-miss, a hit with no damage, or a mobility kill. The duration of *neutralization* is specified by input for each firer weapon-ammunition combination against each target weapon type.	A *neutralized* element's intelligence is affected as follows: (1) an element cannot visually acquire new intelligence when *neutralized*, but receipt of intelligence on radio nets is not affected; (2) a *neutralized* element retains an existing *pinpoint* target; (3) if a *neutralized* element possesses *full knowledge* of its current target, it is downgraded to *pinpoint*; all other *full knowledge* intelligence possessed by the *neutralized* element is downgraded to *general knowledge*.	Not used as no field trial analog existed in Subphases IIIB and IIIE.
SUPRES	Maximum Distance for Near-Miss *Neutralization*. The maximum distance to an element's front at which an impacting direct fire round results in the element's *neutralization* is specified by input for each target weapon type.	Whenever a direct fire round fails to hit its intended target, a check is made to determine whether the round satisfies the near-miss criterion. If so, the *neutralization* procedure is initiated.	Same as above.
MOVPAR$_3$	Length of *Recuperation Period*. The *recuperation period* is the time required by a crew to resume combat activities within its capability after suffering either a firepower kill or a mobility kill. A single value applicable to all elements is specified.	During the *recuperation period*, all combat activities are suspended for the damaged element. They resume when the *recuperation period* elapses.	It was estimated that crew activities would be disrupted for 3 seconds following receipt of survival message.

Table A-I-3d. Weapon System Performance - Weapon Performance Parameters

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
HPRNG	Selected Ranges. Several ranges at which weapon system performance is to be described as specified by input. Although six or fewer ranges are normally used, recent program changes make it relatively easy to accommodate as many ranges as are needed to describe weapon performance.	These inputs specify the values to which both the detailed weapon accuracy data (Table A-I-3e) and the the target vulnerability data (Table A-I-3f) apply. Therefore, they must be selected carefully so that the detailed performance data accurately describe both of these aspects of weapon system performance. In application, the model computes the actual range, target speed, and aspect for an engagement and interpolates in the tables of performance data to obtain suitable values. If the actual values for range, speed, or aspect exceed the range of values specified, the closest specified value and its corresponding detailed data are used to determine hit and kill probabilities.	Ranges and target speeds for which kill probabilities were input were those reported in the classified annex to the CDEC final report. Exact values for the three aspects played were estimated from diagrams depicting sensor placement (See Appendix D).
TARASP	Selected Target Aspects. Several target aspect angles are also selected for describing weapon performance. There is no arbitrary limit established on the number of aspect angles that can be used.		
TARSPD	Selected Target Speeds. The various target speeds for which weapon system performance data are to be specified are input.		
VEHSPD	Selected Firer Speeds. As many speeds as are desired to describe weapon system performance for moving firers are specified.	Additional dispersions (Table A-I-3e) for each of these values of firer speed are specified in the detailed weapon performance data. The interpolation rules outlined above also apply here.	Moving fire not permitted in model runs.

Table A-I-3e. Weapon System Performance - Weapon/Ammunition Performance

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
HITPRB	First Round Dispersions. The total horizontal and vertical dispersions (in mils) and the total horizontal and vertical fixed biases are specified for all single shot firer weapon-ammunition combinations. Values are specified for each of several range intervals, target speeds, and target aspect angles.	These inputs are used in computing probability of hit and for determining whether near-miss actuation occurs. The hit probability computations are performed as follows: (1) The original aim point (Table A-I-3a) is adjusted upward based on the amount of target cover. This adjustment maintains the aim point a specified percentage of the target's exposed height above the ground. (2) If a fixed bias applies (first round case only), the aim point is adjusted in the horizontal and vertical directions accordingly. (3) The total dispersion, *pinpoint* error (if applicable) and additional dispersion for a moving firer (if applicable) are combined to yield a (root mean square) overall dispersion in each direction. (4) It is assumed that impacting rounds are distributed about the adjusted aim point according to a bivariate normal distribution with variance equal to the overall dispersion in each direction. A Monte Carlo procedure is then used to determine whether the shot strikes within the two rectangles representing the uncovered area presented by the target. (NOTE: Shots fired at *pinpointed* targets and shots involving either moving firers or moving targets are always treated as first round case. The model also assumes that hits are always sensed.)	Neither the hit data nor the hit routines were used in the model runs. Instead, the single-shot kill probabilities used by CDEC were used in the model runs.
HITP	Subsequent Round Dispersions. The total horizontal and vertical dispersions (in mils) for rounds following a sensed hit and for rounds following a sensed miss are specified for each single shot firer weapon-ammunition combination for each of the several range intervals.		
FMHITP	Dispersions for Moving Firers. The additional horizontal and vertical dispersions to be included for moving firers are specified for each of several range intervals, firer vehicle speeds, firer mobility types, and rough terrain types (at the firer's location).		
PNPTBS	*Pinpoint* Error. The standard deviations of the aim point error due to *pinpoint* in the horizontal and vertical directions are specified (in mils) as two values applicable to all *pinpoint* firings.		
PMISF	Probability of a Misfire. The probability that a misfire will occur on any given shot is provided as input for each single shot firer weapon-ammunition combination.	Before a main gun or direct fire missile shot is fired, a random number is drawn and checked against this probability to determine whether a misfire occurs. If so, no shot is fired and a time delay is assessed for clearing the misfire.	Not used as no field trial analog existed.
FIRKON RPSIGX RPSIGY TSDXM TSDYM TSDXMS TSDYMS	Rapid Fire Weapon Accuracy. When "rapid fire" weapons are used, a substantial amount of data describing round-to-round dispersions, lengths of burst, etc. are required for each firer weapon-ammunition combination.	(omitted)	No "rapid fire" weapons were employed in either the field trials or the model runs.

Table A-I-3f. Weapon System Performance - System Vulnerability

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
IPRJCT LTHTNK	Organization of Vulnerability Data. Each combination of firer weapon and ammunition against each enemy target type is assigned an identification number. Each combination identifies a permissible firer-target combination for direct fire engagements for which detailed vulnerability data must be provided.	These identification numbers are used to locate the appropriate set of vulnerability data for a given engagement.	The single shot kill probabilities used in the CDEC Casualty Assessment Model during the field trials were also used in DYNTACS. The hit and kill routines were replaced with the kill routine described in the CDEC final report as being used during the field trials.*
PKTNK	Conditional Kill Probabilities. The probability that a kill will result from a hit on a target is specified for each firer weapon-ammunition combination against each target weapon type. Separate probabilities are specified for the four kill types in each of the several range intervals, target aspect angles and target speeds (Table A-I-3d).	A set of kill probabilities is specified for each combination assigned a unique identification number above. The model user decides whether to record kill probabilities for a given combination in PKTNK or TPMKH. The only implication of this decision is that the former permits variation as a function of aspect angle and target speed while the latter does not. The model applies these data by dividing the interval (0,1) into partitions proportional to the probabilities of the various kill types (including a partition for probability of a hit resulting in no damage). A random number is then drawn from U(0,1) and the appropriate kill type is determined by the segment into which it falls.	
TPMKH	Conditional Kill Probabilities. This block specifies kill probabilities similar to those in PKTNK described above except that separate probabilities for each firer weapon-ammunition-target weapon type are not specified for each aspect angle and target speed.		

*NOTE: Three minor differences probably exist between the procedures integrated into the model and those used during the field trials. First, the SSKPs were reported by CDEC to only two significant digits (i.e, ± .005) and these were used in the model rather than the more precise values used by CDEC. Second, CDEC interpolated on range to get the SSKP values for a given shot while the model procedure used the nearest value. Finally, it is not clear whether subsequent rounds were played for gun rounds during the field trials used for the model comparisons.

Table A-I-3g. Weapon System Performance - System Mobility

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN DYNTACS	INPUT DATA SPECIFICATION
MOBILE	General Vehicle Characteristics. A set of general, mobility-related vehicle characteristics is specified for each mobility type to be simulated (Table A-I-1). The following characteristics are specified: (1) Transmission type (automated or manual). (2) Vehicle type (track or wheeled). (3) Gross vehicle weight. (4) Number of forward gears. (5) Final drive gear ratio. (6) Frontal areas. Vehicle Performance Variables. The following performance variables must also be specified by input for each mobility type: (1) Transmission efficiency (2) Final drive efficiency (3) Coefficient of air friction (4) Torque versus engine speed versus output shaft speed	DYNTACS represents in considerable detail several factors that affect an element's ability to move on the battlefield. These include terrain gradient, roughness and trafficability, the enemy situation, friendly tactics, and the physical capabilities of each vehicle. The friendly and enemy situations establish a "desired speed" for each element, while the terrain and the vehicle's mobility capabilities serve to limit the element's ability to achieve this desired mobility profile. A model that transforms these terrain and mobility parameters into a dynamic mobility performance envelope is part of the movement submodel.	The mobility characteristics of the US vehicles actually used in the field trials were specified for the model work.

ANNEX II-A

IDENTIFICATION AND SPECIFICATION OF IUA INPUTS

1. PURPOSE. The purpose of this annex is as follows:

a. To report the results of research performed in identifying the input data requirements of the IUA model and the principal uses of each of these data elements within the model.

b. To outline the approach taken in attempting to specify suitable values for each of these inputs so that meaningful comparisons between model and field trial response data could be made.

2. SCOPE. The input data described in this annex are comprehensive only in the sense that all data required by IUA in simulating the activities of Subphases IIIB and IIIE of CDEC Experiment 11.8 are described. Only tank and antitank missile weapons were included in the IIIB and IIIE field trials; no play of automatic weapons, hand-held antitank rockets, minefields, indirect fire support, attack helicopter operations, air defense operations, or tactical air support was included. All the trials of these two subphases were conducted during daylight hours and under conditions of good visibility. Although IUA possesses capabilities with respect to several of these other aspects of combat, no attempt was made to include descriptions of model inputs other than those required for the Subphase IIIB and IIIE scenarios.

3. CONTENTS. The model inputs are grouped into four functional categories: (1) Definition of Battle Entities, (2) Tactical Scenario Data, (3) Weapon System Performance Data, and (4) Description of the Operational Environment. Tables are presented for each category. The tables are organized into four columns. The first column contains the data variable name most often used in the model. Names in parentheses found in the first column represent the cards on which the data are input to the model. The second, third, and fourth columns contain a description of the data, how it is used in IUA, and the data source used for the TETAM runs.

4. REFERENCE. This document does not include the actual numerical values specified as input for these field trial scenarios or a detailed description of the necessary model modifications. This detailed information is on file in the Combat Operations Analysis Directorate of the Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas.

5. INPUT DATA TABLES. The tables included in this annex are listed below for easy reference.

Table Number	TITLE
A-II-1	Identification of Battle Entities
A-II-2a	Tactical Scenario Data-Tactical Situation at Battle Outset
A-II-2b	Tactical Scenario Data-Intelligence Available at Battle Outset
A-II-2c	Tactical Scenario Data-Organization for Combat
A-II-2d	Tactical Scenario Data-Attacker Scheme of Maneuver
A-II-2e	Tactical Scenario Data-Maneuver by the Defensive Force
A-II-2f	Tactical Scenario Data-Selection of Routes for Tactical Movement
A-II-2g	Tactical Scenario Data-Unit Formations for Tactical Movement
A-II-2h	Tactical Scenario Data-Fire Control Tactics and Techniques
A-II-2i	Tactical Scenario Data-Coordination of Movement and Direct Fires
A-II-2j	Tactical Scenario Data-Tactical Communications
A-II-3a	Weapon System Performance-General System Characteristics
A-II-3b	Weapon System Performance-Target Acquisition Capabilities
A-II-3c	Weapon System Performance-Crew Performance
A-II-3d	Weapon System Performance-Weapon Performance Parameters
A-II-3e	Weapon System Performance-Weapon Accuracy/Round Dispersions
A-II-3f	Weapon System Performance-System Vulnerability
A-II-3g	Weapon System Performance-System Mobility
A-II-4	Description of the Operational Environment

Table A-II-1. Identification of Battle Entities

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
DWCODE NWPN (DFW)	Defender Weapon Codes - Each IUA defender weapon requires two codes describing the weapon type (DWCODE) and a number describing the individual weapons (NWPN).	The weapon type code is used to construct tables describing weapon vulnerability status. The identifying code is provided on all output documents referring to the status of the weapon.	Appropriate defender weapon type codes were selected for the TETAM runs. Defender weapon identifiers were the same as those used in the field.
TWCODE TWPNO [illegible]	Attacker Weapons Codes - Each IUA attacker weapon requires two codes describing the weapon type (TWCODE) and a number describing the individual weapon (TWPNO).	See above description.	Appropriate attacker weapon type codes were selected for the TETAM runs. Attacker weapon identifiers were the same as those used in the field.

Table A-II-2a. Tactical Scenario Data - Tactical Situation at Battle Outset

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
IDEFPS (DGW) KRTD (RT1)	Initial Element Locations. The X and Y coordinates of all defender elements (IDEFPS) and all attacker elements (KRTD) must be specified using the IUA coordinate system. This is a special rectangular coordinate system with the horizontal axis lying along the major axis of attack. All model inputs use this coordinate system. Locations are input to the nearest 10 meters	The model maintains locations of all attacker and defender weapons during the simulation. these locations are used extensively in line of sight computations and range computations for assessment of detection capabilities and weapon effects.	Initial locations for attacker and defender positions were extracted from Appendix D. Defender locations were placed within 50 meters of their exact positions used during the field trials.
DCON (DGW)	Defender *Cover* and *Concealment*. Defender weapons are placed in fixed positions. The model assumes that all defenders are in *hull defilade* positions. No inputs describing *defender cover* are required. IUA plays three levels of *concealment* due to vegetation. Weapon systems are either fully exposed, partially concealed or fully concealed. Defender concealment DCON must be input by the user.	*Cover* is used in the calculation of hit and kill capabilities of enemy rounds fired at the defender. *Concealment* is used to determine the ability of attacker weapons to acquire firing and nonfiring defender weapons. Nonfiring concealed weapons cannot be detected beyond 250m.	Concealment for defender positions was set to be "partial concealment" in conjunction with the degree of concealment outlined in the defensive position analysis.
SCON (RT1)	Attacker *cover* and *concealment* are also required by the model. This information is associated with the attackers assigned *route* and is described in Table A-II-2d.	See Table A-II-2d.	See Table A-II-2d.
OPTYPE (ICC)	Specification of Attacking Force. Input specification must be made describing the battle as either a *Blue attack* or a *Red attack*.	The model uses this information to access the appropriate damage assessment information for each force.	All TETAM battles were conducted as a Red attack.
TWBLD (BLD)	Basic Ammunition Load. Specifies the number of rounds the weapon will have available to fire during the simulation.	The model maintains a record of the rounds currently available to each element. Weapon systems are allowed to engage targets until the *basic load* has been depleted.	Model inputs are identical to the ammunition basic loads used during the field trials.

Table A-II-2b. Tactical Scenario Data - Intelligence Available at Battle Outset

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
PAWSEC (PAQ) NWPN (DGW)	*Previously* Acquired Defender Weapons. Initial intelligence is played in the IUA through the use of *previously acquired* weapon positions. Only *attacker elements* (PAWSEC) have the ability to acquire *defender elements* (NWPN) before the battle begins.	Attackers are assumed to have a complete knowledge of *previously acquired* elements i.e., they are aware of the weapon and its exact coordinates. *Previously acquired* elements can be engaged as soon as line of sight is established with attacker elements.	Defensive elements were marked as *previously acquired* where field trial analysis indicated that attackers had specific knowledge of their position.

Table A-II-2c. Tactical Scenario Data - Organization for Combat (continued next page)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
TWCODE (AMW)	Attacker Force Organization. Weapons in the attacker force are divided into two categories. (1) *Attacker Maneuver Weapons*. The organizational entity for the attacker maneuver force is the IUA *section*. Attacker sections consist of from one to three attacker maneuver weapons. Two sections are placed on each attacker route simulating a *maneuver platoon*. This structure is built into the model and it is the user's responsibility to carefully select sectional *elements*. All weapons in a section should be of the same type since the *movement velocities* and *acquisition* response times entered for each element in the section are assumed to be the same as those of the section leader. (The section leader is the first weapon entered on the AMW card.	Engagement of defensive positions relies heavily on the sectional concept. A recent change in the model causes *line of sight* to be calculated between all *sections* and *defender positions*. The existence of line of sight provides all *elements* of the section the opportunity to detect and subsequently engage the defender. Targets which have been acquired by one *element* of the *section* are immediately acquired by all other *elements* of the *section*. Perfect *intelligence* between sectional elements is assumed during *target assignment*. When facing multiple targets, each element is assigned a different target. Two elements of the same section are never allowed to simultaneously engage the same target.	Where the field trial analysis indicated that two or more attacker weapons moved as a platoon, these elements were assigned to two sections and placed on an attacker route.

Table A-II-2c. Tactical Scenario Data - Organization for Combat (concluded)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
TOWCOD (AOW)	(2) *Attacker Overwatch Weapons*. Attacker overwatch weapons operate as individual battle elements. *Coordinates* of *overwatch positions* and the time of deployment are required model inputs.	As *attacker maneuver weapons* cross the overwatch phase line, overwatch weapons are deployed to their initial positions. The model assumes that crews in attacker *overwatch positions* have *line of sight* with all defender positions. Overwatch weapons are not exposed to other weapons in the battle until they reach their overwatch position.	During the Phase III trials, ATGMs were used both as maneuver and as overwatch weapons. Consequently, the the *overwatch* [illegible] feature of the model was not used. Instead, the overwatch capabilities of the ATGM were simulated in IUA by placing an *obstacle* at points along their trails representing overwatch positions. These positions were taken from the field trial analysis (see Appendix D). The *obstacle* caused the ATGMs to stop for a specified period of time while engaging only those defenders where line of sight had been established by model calculations.
DWCODE (DGW)	Defender Force Organization. The organizational entity for the defensive force is the *individual defender weapon*. Up to 60 defender elements may be played in IUA. Coordinates describing a *primary* and *secondary* position are required for each defender weapon. Attacker weapons are allowed to *advance* along three *axis*. Each defender weapon must use one of these axis as its *primary sector of fire*.	The battle begins with defenders stationed in their *primary position*. If the attacking force reaches a specified *withdrawal line*, the defensive force is allowed to *move* to their *secondary positions*. All defender weapons associated with the same *axis* have perfect communications during *target assignment*. If any other targets are available, a defender will not be assigned to a target already assigned to a defender on the same axis.	Coordinates of defender positions used during the TETAM runs were taken from the RMS tapes generated from the field trials. Only one attacking axis was played for the TETAM runs. All defender weapons were *assigned* to this axis.

Table A-II-2d. Attacker Scheme of Maneuver (continued next page)

BACKGROUND INFORMATION ON ATTACKER MOVEMENTS

The IUA model allows attackers to advance along three primary axes. Within each axis, attackers move along specified tactical routes. Three levels of objectives exist for each attacker. (1) The overall battle objective. (2) The objective of the axis along which the attacker is moving. (3) The objective of the attacker's route. The movement of the attacker is limited to his route objective point. However, the IUA objectives and the axis objectives are used to calculate critical range lines at which attackers are required to perform certain tactical maneuvers. Previous versions of IUA used the route and axis objectives to calculate line of sight to all defender positions associated with these objectives.

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
TAXIS (AMW) TROUTE (AMW)	Attacker Axis and Route of Advance. Attacker weapons must be assigned to a specific *axis* and *route*.	The attacker is associated with a specific *axis* and *route of advance*. The route specifies the attacker's movement coordinates while the *axis of advance* defines his primary *sector of fire*.	Due to the small force size, only one *axis of advance* was used for the TETAM runs. *Routes of advance* were taken from the field trial analysis (see Appendix D).
KRTD(1) (RT) KRTD(2) (RT)	Attacker Route Coordinates. The X and Y coordinates of up to 30 *route descriptor points* must be provided for each *attacker route*.	Attackers move toward battle objectives along rigid routes of advance. *Attacker routes* are approximated by passing straight lines through the *route descriptor points*. The routes are further defined by placing *route sequence points* at 30 meter intervals along these straight lines. As attacker weapons advance, line of sight to defensive positions is calculated at all route *descriptor* and *route sequence points*.	Attacker route descriptor points were taken from Appendix D.

Table A-II-2d. Attacker Scheme of Maneuver (concluded)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
KCRT (RC1) (AC1)	Coordinates of points describing *tactical line of departure* and *attacker mass* and *assault* are specified on each attacker route. The tactical maneuver to be implemented by each unit as it moves along its assigned route is specified by input values establishing the location of several phase lines.	The tactical input data generates a set of *tactical* markers which are placed along the *attacker approach route*. These *phase lines* define *tactical maneuver areas*. As the attacker weapons move through areas, they perform the tactical maneuver associated with phase lines. Attacker elements adhere rigidly to the *tactical phase lines*. They will perform the predefined tactics regardless of their losses or the proximity of the defender weapons.	Positions of attacker *phase lines* were chosen from the field trial analysis (see Appendix D).

Table A-II-2e. Tactical Scenario Data - Maneuver by the Defensive Force

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
DX DY (DGW) KCRT (AC1)	Defender Secondary Positions. Coordinates of *defender secondary positions* and the location of the *defender withdrawal line* must be specified by the user.	Defender weapons are allowed to have a *primary* and *secondary* firing position. The battle begins with defenders in their *primary position*. These positions are held until the attacking force crosses the *defender withdrawal phase line*. At this point in the battle, defenders move to their *secondary firing positions*.	Secondary positions were not used in the TETAM runs.

Table A-II-2f. Tactical Scenario Data - Selection of Routes for Tactical Movement (continued next page)

STATIC SELECTION OF ATTACKER ROUTES AND FIRING POSITIONS			
Routes followed by attacker weapons must be selected by the model user prior to execution of the model. The routes and desired firing positions are input to the model as a set of sequential points (See Table A-II-2d). The model requires that attacker maneuver units follow the exact paths and use only those firing positions specified by the input data. No deviations from these trails or firing positions are allowed during the battle. Careful selection of firing positions along the routes must also be made to insure that line of sight exists between the firing weapon and all desired targets.			
BLOCK NAME	**DESCRIPTION OF INPUT DATA REQUIRED**	**DATA APPLICATION WITHIN IUA**	**INPUT DATA SPECIFICATION**
SCON(1) SCON(2) (RT1)	Concealment Along Route. Data describing the *concealment* afforded by *local vegetation* must be provided for each *route descriptor point*. The concealment must be of two types, SCON(1) describing concealment for vehicles utilizing only minimal concealment and moving in the *open route*, SCON(2) describing vehicles utilizing maximum concealment moving along a *covered route*.	The model plays 3 types of concealment at each route descriptor point: 1. *Fully exposed* SCON= 2 2. *Partially (hull) concealed* SCON= 1 3. *Fully Concealed* SCON= 0 As attacker weapons move toward defender positions, they can be acquired by either *firing or nonfiring cues*. The concealment codes are used during *nonfiring detection* of	Concealment codes other than 2 were applied only to those points where the field trial analysis indicated that attackers deliberately moved through concealed areas to avoid detection by the defensive force.

Table A-II-2f. Tactical Scenario Data - Selection of Routes for Tactical Movement (continued)

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
		attacker weapons. When *line of sight* occurs between nonfiring defender position and attacker, the following rules are used to determine the ability of the defender to acquire the attacker. 1. If the attacker is *partially* or *fully concealed* and at a range greater than 750m then the defender cannot acquire the attacker. 2. Between 750m and 250m a stationary attacker either *fully* or *partially concealed* cannot be detected. A moving attacker in this area can be acquired if the defender can react before line of sight is lost. 3. At ranges less than 250m both stationary and moving attackers in a *partially* or *fully concealed* area can be acquired if the defenders response time is sufficiently short. It should be noted that the range intervals described above are calculated between the attacker position and the attacker route objective point. The defender position is not used in the range calculation. *Concealment* of the current *route descriptor point* is maintained until the next *route descriptor point* is reached.	

Table A-II-2f. Tactical Scenario Data - Selection of Routes for Tactical Movement (concluded)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN MODEL	INPUT DATA SPECIFICATION
KROUGH (RT)	<u>Mobility Factors Along Route</u>. Two types of *mobility factors* must be provided for each *route descriptor point*. (1) Soil Type. One of five different soil types must be described for each route descriptor point. Each type is associated with a *specific trafficability* characteristic for *maneuver vehicles*. The following table lists the soil types in ascending difficulty of trafficability. 1. Heath: Sandy soil. 2. Foothill: Plastic clay. 3. Plains: Silt and clay. 4. Meadows: Sandy, silty, clay (poorly drained) 5. Marshland: Peat, silt, and clay (always wet). (2) Terrain Roughness. One of 6 different *soil roughness* categories must be specified for each route descriptor point. 1. Level meadows. 2. Fields with overpass roads. 3. Frozen plowed fields. 4. Rolling meadows. 5. Stony farmland. 6. Heavily used tank road.	*Soil type* and *terrain roughness* associated with each *route descriptor point* are used by the movement model to select the *limiting velocity* at which a vehicle can move past the *route descriptor point*. The vehicle will continue to move at this limiting velocity until the next *route descriptor point* is reached.	Soil type 1 was used for all TETAM runs. Appropriate terrain roughness codes were determined from maximum velocities achieved by the threat force during the Phase III runs described in Appendix D.
KRTD (RT)	<u>Selection of Firing Positions Along Route</u>. The X and Y coordinates of *firing positions* for all *attacker maneuver sections* executing a *fire and move* tactic must be specified by the user. Care must be taken in the choice of firing positions, to insure that *line of sight* exists between the *firing position* and all desired *defensive targets*.	Attackers move toward battle objectives along rigid routes of advance. Sections executing a *fire and move* tactic can stop and fire only when reaching a specified *firing position*. Attacker weapons not having a *fire on the move* capability cannot fire as they move between *route descriptor points* although they can acquire defender weapons which will be engaged at the next route descriptor point.	Coordinates of overwatch firing positions for ATGMs were selected from the field trial analysis (see Appendix D). *Fire and move* areas for T62 tank platoons were chosen using the field trial analysis. Coordinates of actual firing positions within these areas were judgmentally selected considering the tactical soundness (line of sight to potential defender targets) of these positions.

Table A-II-2g. Tactical Scenario Data - Unit Formations for Tactical Movement

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
TRAILC TRAIL (TMC)	Attacker Maneuver Unit Formation. When *attacker maneuver* forces on the same route consist of mixed platoons (i.e tanks and APC's) it is often desirable to have a section of one weapon type trail sections of another type. The *trailing sections* weapon type TRAILC and the *distance*, TRAIL it must remain behind the lead section are required by the model. It is not necessary to have all vehicles in a section of the same type. However, the type and movement characteristics of a section are defined as those of the first vehicle in the section.	*Attacker maneuver weapons* advance toward their objective in section formations consisting of from 1 to 3 vehicles. Two sections are assigned to the same route. When executing *fire and move* tactics sections may move by *successive* or *alternate bounds* (see Table A-II-2i) for a complete description of fire and move tactics). Sections may also advance with one section trailing another by the specified distance. Only one set of coordinates are maintained for each section. Hence all weapons within the section are assumed to be at the same location.	Trailing vehicles were not used during the TETAM runs.

Table A-II-2h. Tactical Scenario Data - Fire Control Tactics and Techniques (continued next page)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
AWT (BWP) (RWP)	Target Selection by Defender and Attacker Weapons. The *threat potential* of each enemy weapon must be provided for each firing weapon. The *target threat potential* is measured on a scale of 0 to 5 with 0 representing no threat to the firer.	Firers having acquired multiple targets are assigned to fire at the target having the greatest *effective priority*. This priority is calculated for each potential target by summing the following three factors: (1) *Target threat potential* (AWT) representing the desired engagement priority of the firer for the target.	Blue Target Priorities. During the Phase III field trials, blue gunners appeared to show no preference for either ATGM or T62's. Consequently, threat potentials were set to 5 for both systems. ICV's were given a threat potential of 1.
DPRT (DGW) TROUTE (AMW) DPAX (DGW) APAX (AMW)	The *primary fire sector* described by the primary route and *primary axis* must also be provided for all attacker and defender weapons.	(2) *Target Axis*. If the potential target and the firer are on the same *primary axis* (DPAX, APAX) their target is in the firer's *principal fire sector* and a weight of 3 is added to the priority.	The IUA TETAM runs were conducted using one axis of advance with all attacker and defender weapons assigned to the same primary axis.

Table A-II-2h. Tactical Scenario Data - Fire Control Tactics and Techniques (concluded)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
		(3) *Target Route*. If the potential target is on the firer's primary route (DPRT, TROUTE) a weight of 1 is added to the priority.	Defender weapons were assigned to those routes which terminated closest to their positions. Red Target Priorities. All blue weapons were considered to represent a threat potential of 5 against all Red firers.
KCRT (AC1)	Defender Open Fire Line. The position of the *open fire phase line* for the defensive force must be specified by the user. The position is determined by specifying the *range* from the *axis objective point*.	Defender force elements are not allowed to fire until the threat force has crossed the *defender open fire line*. After attackers have passed this point, defender elements fire independently and are constrained only by the maximum range of their rounds.	Defender open fire lines were set at appropriate ranges, described in Appendix D, when simulating trials where fire control on the defensive force existed. On other trials, the open fire line was set at 3500m allowing the defenders to engage the moment targets came within missile range.
RNDPR (RDP)	Round Priority. Round priorities must be provided for every potential target firer combination Priorities may range from 5 (highest) to 0 (can't fire this round). The priorities are the basic consideration for selection of available rounds to be fired at an Two priorities must be provided for each round. One for engaging targets beyond 1200m and a second for engaging targets at ranges less than 1200 m.	*Crew performance* in IUA is measured by their ability to select the most lethal target/round combination from a set of acquired targets and available rounds. Round priorities (RNDPR) are used to construct a set of tables which provide the most advantageous round combinations.	Only the M60 carrying both the Shillelagh and the heat round had the option of selecting rounds during Phase III runs. During the IUA test runs, the Shillelagh was given a round priority of 5 and the heat round a priority of 4 for all ranges.

Table A-II-2i. Tactical Scenario Data - Coordination of Movement and Direct Fire

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
KCRT (RC1)	Fire and Move Tactics. *Fire and move* areas must be specified for each *attacker route*. As attacker platoons traverse this portion of the *route* they will execute a fire and movement tactic with *sections* using either *alternate* or *successive bounds*. The *fire and move phase line* is placed at a range of KCRT meters from the *route objective point*.	In order to execute *fire and move* tactics, IUA requires 2 attacker *sections* assigned to each route. *Sections* move together until crossing a *fire and move phase line*. They then begin moving by *successive bounds* or *alternate bounds* depending on the value of FAMFLG (1=alternate bounds, 2=successive bounds).	Input coordinates describing *fire and move* phase lines were selected from the field trial analysis. Route descriptor points representing firing positions were selected every 100m to 300m within the fire and move areas.
KCRT (RC1)	Moving Fire Tactics. Attacker weapons having a *fire on the move* capability are allowed to execute this tactic after they cross the *moving fire phase line*. This line is located on each route by its range (KCRT) from the route objective point.	*Fire on the move* weapons in sections that have crossed a *moving fire line* can engage acquired targets while moving between *route descriptor points*. These are the only weapons that are allowed to engage targets at positions between *route descriptor points*.	*Fire on the move* capability was not simulated during the Phase III trials on the IUA runs.
KCRT (AC1)	Attacker Mass Line. After moving through a fire and move area attacker weapons may *mass* for a *final assault*. The attacker *mass phase line* is located at the specified range (KCRT) from the axis objective point.	Attacker *sections* reaching the *route descriptor point* representing the *mass line* on their route are held until all surviving sections reach their respective *mass lines*. The entire attacker force then moves toward their *route objectives*.	Attacker mass lines were used in those runs where the field trial analysis indicated that this was the appropriate tactic.
KCRT (RC1)	Attacker Assault Mode. Attacker sections crossing an assault phase line proceed in assault mode. Assault lines are located on each trail at the specified range (KCRT) from the *route objective point*.	*Sections* crossing their *assault line* move directly toward their *route objective point*.	Assault phase lines were used to simulate Phase III trials where field trial analysis indicated that they were appropriate.

Table A-II-2j. Tactical Scenario Data - Tactical Communications

DESCRIPTION OF INTELLIGENCE RULES
IUA does not explicitly play tactical communications. However, there are some assumptions made in model coding which lead to some implicit communication rules.
(1) Defender weapons acquire targets independently. No communication exists between force elements in a defending force when acquiring targets. However, perfect communication exists between elements on the same axis in terms of fire coordination. During target assignment only one of the acquiring defenders will be allowed to engage the target.
(2) No communication exists between attacker sections. However, elements within the same section have perfect communication. Defender weapons are acquired simultaneously by all weapons within a section. During target assignment two firers within the same section will not be assigned the same target.

Table A-II-3a. Weapon System Performance - General System Characteristics

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
DMVFMY (TDF) DIMVMX (TDF) DMVFPY (TDF) DIMVPX	<u>Target Dimensions</u>. Four *dimensions* describing the *silhouette area* of each potential target are required by IUA. These dimensions represent the *height* (DMVFMY) and *length* (DIMVMX) of the *hull* and the *height*(DMVFPY) and *length*(DIMVPX) of the *turret*.	These values are used to calculate the size of the *target silhouette* when determining whether a round has hit or missed a target. If a target is *fully exposed* both *hull* and *turret* dimensions are used to calculate the size of the target. The aim point is assumed to be in the center of the line dividing during the hull and turret area. If the target is in *hull defilade* the aim point becomes the center of the turret and these dimensions are used to calculate the resulting target area.	The weapon dimensions used during the IUA TETAM runs were provided by AMSAA
RNDCAP (RDC)	<u>Round Range Capability</u>. The *maximum effective range* must be specified for each round.	Once a target has been acquired, the distance from the firer to the target is calculated. If this distance is greater than the *maximum effective range*, the round will not be fired.	The maximum range capability used for all rounds played in IUA were the same as those used in the TETAM field experiment
VPROJ (RDC)	<u>Round Velocity</u>. Velocities (m/sec) at seven *range intervals* from 250m to 3000 m must be specified for each round.	The velocities are used in computing the *time of flight* for the round.	Velocities used for rounds played in IUA were the same as those used in the TETAM field experiment.

Table A-II-3b. Weapon System Parameters - Target Acquisition Capabilities (continued next page)

BACKGROUND INFORMATION ON IUA ACQUISITION PROCEDURE
The IUA detection model simulates *target acquisitions* resulting from *firing cues* and *non-firing cues*. Once a target has been *acquired*, its exact *coordinates*, *range*, and *weapon type* are known. The model does not play partial knowledge such as approximate coordinates or estimated weapon type of a potential target. A crew either has total knowledge of a target's location of no knowledge of its presence. Once acquired, a target location is known throughout the remainder of the game. The following paragraphs provide a description of the procedure used to determine *firing* and *non-firing acquisitions*.

Table A-II-3b. Weapon System Parameters - Target Acquisition Capabilities (continued)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
RNDACQ (RDC)	<u>Acquisition of Firing Weapons</u>. The probability of detecting a firing weapon as a result of its firing signature (flash, smoke, dust and noise cues) must be provided for each round.	Each time a weapon fires, all enemy crews on the same *axis* with line of sight to the firing weapon have an *opportunity* to acquire it. *Firing acquisitions* for each observing crew are determined by comparing their probability of acquisition with a uniform random variant. The probability of acquisition is computed using the following equation: $PA = 1 - (1\text{-}RNDACQ)^{kn}$ where PA = *Probability of acquisition* for observing crew; RNDACQ = *Probability of acquiring* the weapon from firing a single round; k = Parameter describing the posture of the firer. For weapon firing on the move, k=1.5, for stationary weapons k=1; n = number of rounds fired during which search crew had the opportunity to detect	Probabilities of acquisition used during the IUA test runs were provided by AMSAA
PRAWACQ	<u>Acquisition by Non-Firing Weapons</u>. These *acquisitions* are a result of *target movement* and *random sightings* of *stationary* targets. The probabilities for *detecting* both *stationary* (PRAWACQ(1)	Each time line of sight is established between two enemy elements on the same *axis*, both are given the *opportunity to acquire*. The ability of a searching crew to acquire a *non-firing*	*Probabilities of acquisition* and factors for time to acquire were taken from the Lockheed Data Base

Table A-II-3b. Weapon System Parameters - Target Acquisition Capabilities (concluded)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	[illegible]
PRAWACQ(2) (P[illegible])	[illegible] moving (PRAWACQ(2)) targets in 500 meter range [illegible] from 0 to 3000m must be specified for crews operating each weapon system being simulated.	target is dependent on the [illegible] of the target. If the status of the target is not [illegible] exposed and fully uncovered the target is not detectable beyond 750 meters for moving targets and 250 meters for stationary targets.	
RFTAW(1) RFTAW(2) (FTA)	A [illegible] for crew acquisition time must also be specified for both moving and stationary targets.	If the target is *completely exposed* and *completely uncovered* a *probability of detection* (PRAWACQ) is compared with a uniformly distributed random number. The probabilities represent the ability of the searching crew to *initially detect* or sense the presence of the non-firing target. If the detection occurs, an *acquisition time* is generated from a lognormal response distribution. This time is multiplied by the RFTAW factor representing weapon movement and range. Acquisition occurs if *line of sight* still exists at the end of the *acquisition period*. Once a weapon has been acquired, its coordinates remain known to the acquiring system for the remainder of the game.	
DVSC (DGW) TNVIS (AMW)	**Maximum Night Visibility Range.** This is the maximum range at which searching crews can *acquire* a *potential target* at night. A *maximum visibility range* must be specified for each weapon system.	Neither *firing* or *non-firing acquisition* at night will be allowed to acquire targets beyond the *maximum visibility range* of the searching crew.	IUA was not tested against the Phase III night runs.

Table A-II-3c. Weapon System Performance - Crew Performance

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
RESPON(1) RESPON(2) (RVM)	Load, Lay and Fire Times (Stationary Firer vs Stationary Target). The median time for *stationary crews* to *lay and fire first rounds* (RESPON(1)) must be provided for engaging *stationary targets* at 500m range intervals from 0 to 3000m. First round engagements assume that the round has been loaded prior to the beginning of the engagement. Median times for *subsequent rounds* (RESPON(2)) include *load, lay and fire time.*	Once a round has been selected, a *response time* representing the gunners ability to *lay and fire* his weapon is calculated using the following equation: R_t = (RESPON)(RFCRT) X where R_t = *Gunner response time* required to lay and fire weapon RESPON = Median response time to *lay and fire* weapon RFCRT = Factor representing change in reaction time due to *movement* of *target and firer* X = A random variant drawn from a lognormal distribution (μ = 1.065, σ = 1.3) The assumption is made by the model that the optimal first round is always carried in the tube.	Median response times for initial responses were provided by AMSAA Subsequent response times were played in IUA using the same reload times as those used by CDEC during Phase III. Response time factors for well trained crews were provided by AMSAA
RFCRT(1) (CRT)	Response Time Factors (Moving Firers and Moving Targets). A factor representing the change in response time (RFCRT(1)) for *moving* crews to *lay and fire* an initial round and *load, lay and fire* on subsequent rounds must be provided for each *fire on the move* round.		
RFCRT(2) (CRT)	A factor representing the change in response time for *stationary firers* engaging *moving targets* must also be specified for each round.		

Table A-II-3d. Weapon System Performance - Weapon Performance Parameters

RNDFOM (RDC)	Fire on the Move Capability. Rounds which can *fired on the move* must be specified.	Only specified rounds can be used to engage targets as firers move between *route descriptor points.*	Fire on the move rounds were not played during the TETAM Experiment.
RTYPE (RDC)	Guided Round Indicator. All guided rounds must specified.	Crews firing *guided rounds* must have continual *line of sight* with their target while the round is in flight. If *line of sight* is interrupted, the firing results in a miss.	The TOW, DRAGON, Shillelagh and Sagger were played as guided rounds during the Phase III, IUA runs.
RNDREL (RDC)	Round Reliability. The *probability* that a round will not *misfire* must be specified.	The *round reliability* (probability of a successful firing) is used to determine *round misfires.*	Round reliability used in the TETAM field tests were included in the probability of kill given a shot. Consequently, reliability was set at 1.0 for the IUA runs.

Table A-II-3e. Weapon System Performance - Weapon Accuracy/Round Dispersions (continued next page)

BACKGROUND ON HIT CALCULATIONS

The IUA model uses three methods to determine targets hits by firing weapons. The method used is dependent upon target type.

(1) Handheld Weapons. Results of a firing against handheld weapon targets are assessed using single shot kill probabilities. These are unconditional probabilities (implying both hit and kill) which are input to the model.

(2) Vehicular Weapons. Hits against vehicular and ground mounted targets are determined by calculating the distance of round impact from the center of the target. The following equations are used to determine miss distance:

$$M_x = R\,Z\sqrt{\sigma T_x^{\,2} + \sigma F_x^{\,2}}$$

$$M_y = R\,Z\sqrt{\sigma T_y^{\,2} + \sigma F_y^{\,2}}$$

Where M_x, M_y = the horizontal and vertical distances of the point of impact from the center of the target.

R = the range from the firer to the target.

Z = a random number generated from a standard normal distribution.

σT_x, σT_y = round dispersion due to the target. This dispersion is a function of target range and movement.

σF_x σF_y = round dispersion due to the firer. This is a function firer movement and range to the target and the number of rounds previously fired at the target. Range dependent dispersions are input for each 500 meter range band between 0 to 3000M. Velocity dependent dispersions are input for each 10 km/hr velocity intervals between 0 and 40 km/hr. For ranges and velocities falling within these bands, dispersion values are linearly interpolated.

Hits against vehicular targets are assessed by comparing the miss distances with the target dimensions. All rounds falling within the target silhouette are considered a hit.

(3) Ground Mounted ATGM Targets with Crews. Round impact on ground mounted ATGM targets are assessed against the crew and the weapon system. If the miss distance equations indicate that the round did not impact on the ground mounted weapon system, then damage against the crew is assessed using the single shot kill probabilities.

The following input card formats describe the single shot kill probability and the dispersion data required by the model.

Table A-II-3e. Weapon Accuracy/Round Dispersions (concluded)

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
SSKP (SKP)	Single Shot Kill Probabilities. Kill probabilities must be specified for *burst fire* weapons against all targets. Probabilities must be provided for first and subsequent bursts at 500m range bands from 0 to 3000m.	See Above Description	Round dispersions were not used in the IUA runs made for the TETAM tests. All hits and kills were assessed using the same single shot kill probabilities that were used in the CDEC real time casualty assessment model.
DISPX DISPY (DFO) (DSH) (DSM)	Round Dispersions (Stationary Firer vs Stationary Targets). *Round dispersions* are for *stationary firers* engaging *stationary targets* must be specified for 500 meter range intervals at ranges of 0 to 3000 meters must be specified all rounds engaging vehicular targets. Dispersions are required for first round (DFO) shots and *subsequent rounds* given a *hit* (DSH) and subsequent rounds given a miss (DSM).	See Above Description	See Above Description
MDFISP (MIA)	Round Dispersions (Moving Firer vs Stationary Target). Range dependent dipspersions must be specified for first and subsequent round fired by vehicles moving at 0 to 10 kph at stationary targets.		
MTDISP (MTO)	Round Dispersions (Stationary Firer vs Moving Target). Range dependent dispersions must be specified for *first* and *subsequent rounds* fired by *stationary* crews at targets moving at speeds up to 40 kph.		

Table A-II-3f. Weapon System Performance - System Vulnerability

BLOCK NAME	DESCRIPTION OF DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
VULNER-ABILITY DATA FILE VULDAT	Vehicular Target Versus Single Shot Rounds. This information is provided primarily by Ballistics Research Labs (BRL) and Army Materiel Systems Analysis Agency (AMSAA). The data is entered into the Vulnerability Data File (VULDAT) for each *weapon system/round type* combination includes the probabilities of kill for ranges up to 3000 meters at 500 meter increments, against *defilade* and *fully exposed* positions.	For each engagement during the IUA, one of the measures of effectiveness is the type kill obtained by a firing weapon. Once the target is hit, the four standard NATO type kill categories (*firepower, mobility, firepower and mobility-repairable, and total kill*) are computed according to their probability of occurrence. This computation is based on *range, round dispersion, aspect angle, exposure and movement* capabilities of the target. A Monte Carlo technique is then used in determining the actual representative kill that has resulted from the engagement.	Probabilities of kill given a shot used during the Phase III runs were used for assessment of each vehicle round combination.
SSKP (SKP)	Other Vulnerability Data. Vulnerability data for non-vehicular targets versus all rounds are input into the SSKP array. These are probabilities of kill for first and subsequent rounds over a range of 3000 meters at 500 meter increments.	For those targets that are non-vehicular or the type round is burst fire, the SSKP array is accessed for appropriate probabilities of kill.	Probabilities of kill given a shot used during Phase III field trials were used for the IUA runs.

Table A-II-3g. Weapon System Performance - System Mobility

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION.
VRIDE VFIRE VNIGHT VDEG VLT	Velocity Limitations. A set of *velocity limitations* is specified for each *attacker maneuver weapon* system to be simulated. The following limitations are specified as a function of *terrain type*. (1) Crew Tolerance - VRIDE (2) Moving Fire - VFIRE (3) Night Movement - VNIGHT (4) Periods of Degraded Visibility - VDEG (5) Various gradients - VLT	The mobility preprocessor (MOBVAR) provides for the simulation of mobility for the attacking force. MOBVAR moves the attacking force from the *line of departure* along preselected routes toward the *objective* and *reorganization point*. Data describing various velocity limitations, delays due to obstacles, and acceleration/deceleration factor as a function of *terrain type* are input for each *attacker maneuver weapon*. These parameters provide the necessary values that are used to calculate the velocity of the attacker force at points along the attack route.	The velocity representing crew tolerances was the primary limiting velocity used in the TETAM runs. Velocities for the M60 and M113 representing the T62, ATGM and ICV, were taken from Appendix D.
KCC	Acceleration/deceleration factors.	Factors are used to calculate the effects of *acceleration/deceleration* on the average velocity of a vehicle over a 30 meter movement segment.	The acceleration/deceleration factors for the M60 and M113 were taken from the Report of Simulation Support for the Evaluation of Candidate Tank Configurations.

Table A-II-4. The Area of Operations - Terrain Data

BACKGROUND

Describing the terrain area to be used in the IUA involves the manual coding of data developed through analysis of standard Army maps. The area of operations usually is 5 x 8 kilometers which will provide enough land area to allow a variation in tactics to be played.

The *Variable Triangle Method* is used in preparing the Army map sheet for encoding data into the card formats necessary to represent the IUA terrain area. This method calls for describing the land area as a series of small triangles where the verticies of these triangles are elevation points and the *average height of vegetation* is recorded for each triangle.

BLOCK NAME	DESCRIPTION OF INPUT DATA REQUIRED	DATA APPLICATION WITHIN IUA	INPUT DATA SPECIFICATION
NXYZ NFIG IFIG (CN)	Number of Vertices. Total number of vertices created in developing the Terrain Area. Number of Triangles. Total number of triangles created in developing the Terrain Area. This array holds the identifying numbers of each of the triangles.	In the Terrain Preprocessor (TERVAR) the triangles identified are used to locate within arrays IXYZ and KDLH the appropriate elevation and vegetation height of a particular location. The elevation and vegetation height are then used to compute program variables such as SLOPE of the battlefield at any given point, and line of sight between competing weapon systems.	The TETAM Hunter-Liggett test site was used in preparing the Terrain Area to be played in IUA. Established methods prescribed in preparing IUA Terrain Data Base were used.
KDLH (DH)	Average height of vegetation for the representative terrain area that is being played in IUA.	The height of vegetation is placed in the common data array KDLH and used in the terrain preprocessor in determining if line of sight exists between two elements.	
IXYZ (MV)	This array identifies the X, Y *coordinates* and *elevation* of each vertex number developed as a result of following the procedures of creating the IUA terrain area.	The points of elevation are used by the Terrain preprocessor "TERVAR" to define a triangular plane from which elevation for any unit that is located within the triangular area can be derived.	

APPENDIX B

MODEL BIBLIOGRAPHY

APPENDIX B

MODEL BIBLIOGRAPHY

B-1. PURPOSE. This bibliography lists model documentation that was available during the TETAM Model Verification study. The bibliography is listed in annotated form as an aid to future users of the models. This bibliography is not necessarily an exhaustive list of models documentation, but the major sources that will probably be available to a user are included.

B-2. CONTENTS. The appendix is organized into three annexes, one each for DYNTACS, IUA, and CARMONETTE.

a. Annex I--DYNTACS. Documentation of DYNTACS is extensive, and the bibliography is close to being exhaustive. DYNTACS documentation is unique in that much of the early research that fed into the model development is documented as well as the model itself. Thus, this is the only model for which the basis of most of the model representations can, with sufficient research, be found.

b. Annex II--IUA. Documentation of IUA is best described as spotty. Adequate information exists only on the mechanics of operating the computer programs. No meaningful documentation of the basis for most of the model formulations has been found. Model logic flow is reasonably documented in flow chart form. No discussion of the ramifications of various input values is available; however, data bases that have been used are available. It appears that users may tend to use these bases without question.

c. Annex III--CARMONETTE. A set of CARMONETTE documentation has recently been produced. This provides a reasonable picture of gross model logic, some of the model algorithms, and the mechanics of program operation and data preparation. Some discussion of the ramifications of certain data items is also included. No documented basis for the formulations contained in CARMONETTE has been found. Older CARMONETTE documentation has not been included in the bibliography since none has been found that is not redundant with the current documentation.

ANNEX B--1

ANNOTATED BIBLIOGRAPHY FOR DYNTACS

1. EARLY REPORTS OF BACKGROUND RESEARCH AND PRELIMINARY MODEL CONCEPTS.

a. Bussman, Dale R. Vibrations of a Multiwheeled Vehicle. Ohio State University, TR64-1, August 1964.
Equations describing tank movement on a terrain surface are presented.

b. Howland, Daniel and Bonder, Seth. The Tank Weapon System. Ohio State University, AR63-1, June 1963.
Describes a general model to guide and integrate research in the related areas of tank mobility, firepower, and survival.

c. _____. The Tank Weapon System. Ohio State University, PR64-1, December 1963.
Research in the areas of soft soil ability and cross country mobility is presented. The effects of cant on the accuracy of the tank main gun are reported.

d. _____. The Tank Weapon System. Ohio State University, AR64-1, June 1964.
Tank mobility in soft soil or rough terrain is discussed. Development of the target acquisition and fire control models is described.

e. _____. The Tank Weapon System. Ohio State University, AR65-1, June 1965.
Separate computer models are described for firing, mobility, hit probabilities, lethality, acquisition, and armor distribution.

f. Perloff, William H. Tank Mobility in Soft Soils. Ohio State University, TF65-2, June 1965.
Describes a computer program for soft soil mobility analysis. Covers track slippage and tank sinkage.

2. INITIAL INTEGRATED MODEL.

a. Howland, Daniel and Clark, Gordon. The Tank Weapon System. Ohio State University, AR66-1, June 1966.
The DYNTACS model is first referenced in this manual. A model overview is presented and a detailed description of five modules, (1) terrain and environment, (2) tactical decision, (3) intelligence, (4) movement, and (5) firing, is included.

b. _____. The Tank Weapon System. Ohio State University, AR66-2, December, 1966.
Equations describing the probability of detection and time to detection between an observer and tank are presented. A field experiment to validate those equations is reported. Microterrain and power spectral density

as used in the ground play of line of sight are discussed in detail. Detailed descriptions of concealment input parameters PCCS and YMAX are included. Soil strength and limiting speeds for tanks are also discussed.

3. THE BASIC GROUND MODEL NOW RECOGNIZED AS DYNTACS.

a. Bishop, Albert and Clark, Gordon. The Tank Weapon System. Ohio State University, AR69-2A, October 1969.

The first of two principal analyst manuals for users of the DYNTACS manual. Although these volumes describe in detail only the early version of the model known as DYNTACS, documentation of subsequent changes, improvements, and additions to the model describe only those parts of the model actually changed. Thus, the model descriptions in these two analyst manuals apply except where changed by subsequent volumes. This volume contains detailed descriptions of the DYNTACS submodels developed to simulate (1) terrain and environment, (2) communications, (3) intelligence (i.e., target acquisition), and (4) movement control.

b. _____. The Tank Weapon System. Ohio State University, AR69-2B, September, 1969.

The second of two principal analyst manuals for users of DYNTACS. The remaining five modules comprising the DYNTACS model are described: (1) the fire controller, (2) the movement model, (3) the firing model, (4) the minefield model, and (5) the indirect fire ballistic weapon (i.e., artillery) model.

c. _____. The Tank Weapon System. Ohio State University, AR69-4, September 1969.

This volume is appended to the AR69 series to provide the reader an overview of this early research and its principal results. Perusal of this volume should provide an appreciation of the significance of the original methodology produced and a measure of its potential usefulness in the reader's area of involvement. It is essentially an executive summary of the early work.

d. Bishop, Albert and Stollmack, Stephen. The Tank Weapon System. Ohio State University, AR68-1, September 1968.

This volume is valuable for its development of the detection process still used in DYNTACS. Chapters covering concepts of visual detection, contrast-dependent detection, probability for stationary targets, target contrast, and analysis of detection time data are included. Other less important areas discussed are availability, reliability, rough terrain, limiting speed, and a methodology for predicting overall dimensions and gross weight.

e. Clark, Gordon and Moss, Leslie. The Tank Weapon System. Ohio State University, AR69-3A, June 1969.

This volume describes the design and use of the DYNTACS computer program. Included in this volume are subroutine descriptions and flow charts, detailed descriptions of the data used in DYNTACS, a description of how data are prepared for input to DYNTACS, instructions for running the program, and sample outputs. Due to the fact that DYNTACS is no longer run on the same computer and extensive modifications have been made to the ground game, this volume is now of little value to most users.

f. _____. The Tank Weapon System. Ohio State University, AR69-3B, June 1969.

This volume, a continuation of AR69-3A described above, is now of little value to most model users.

4. DYNCOM--THE FIRST MAJOR EXPANSION.

a. Bishop, Daniel and Clark, Gordon. The Land Combat Model (DYNCOM). Ohio State University, FR-1, June 1969.

This volume describes the design principles of the DYNCOM model. DYNCOM is a modification and extension of the DYNTACS model. This volume only describes modifications and extensions to the DYNTACS model; therefore, 69-2A and 69-2B must be read prior to this volume to get the complete description of the DYNCOM model. Major additions documented in this volume are artillery, crew-served weapons, and beam-rider missile modules. Associated modifications to movement and firing tactics are also presented as well as a significant reworking of the communications model. Additionally, research of some significance in modeling concealment, limited visibility conditions, and air/ground and ground/air visual detection are reported.

b. Clark, Gordon; Parry, Sam; Hutcherson, Don; Rheinfrank, John; and Petty, Gerald. Land Combat Model (DYNCOM) Programers Manual. Ohio State University, FR70-4A, April 1970.

This programers manual is a comprehensive list of input data commons, program descriptions, and flow charts of DYNCOM. Because FR70-4A and FR70-4B cover the complete model, it is not necessary to refer to earlier manuals. A cross reference listed in this manual between common areas and chapters which describe the model can be a valuable tool for preparing input data.

c. _____. Land Combat Model (DYNCOM) Programers Manual. Ohio State University, FR70-4B, April 1970.

This volume is a continuation of FR70-4A. The programers manual was broken into two volumes for ease of handling.

d. Clark, Gordon and Hutcherson, Don. Land Combat Model, The Aerial Platform Combat Operations Model. Ohio State University, FR71-3, May, 1971.

Documents the aerial platform module developed for DYNCOM. This module seems to have had limited acceptance, and the volume is not of great interest.

5. DYNTACS-X SECOND MAJOR EXPANSION.

a. Clark, Gordon and Parry, Samuel. Small Unit Combat Simulation (DYNTACS(X)) Counterbattery Fire Models. Ohio State University, FR70-1, July 1970.

The DYNTACS(X) version is an extension to the DYNCOM version. This volume reports the addition of a counterbattery fire module. As might be expected, it has no direct impact on the basic ground combat module.

b. Clark, Gordon et al. Small Unit Combat Simulation (DYNTACS(X)) Air Defense Operations Model. Ohio State University, FR71-2A, March 1971.

As the title suggests, this volume documents inclusion of an air defense capability into the model. This differs from most other model expansions in that it could not be incorporated modularly but rather required extensive elaborations to the basic ground combat detection, firing, and fire control modules. A companion report (same authors, title, and date, issued as FR71-2B) contains flow charts and data layouts.

c. Clark, Gordon and Hutcherson, Don. Small Unit Combat Simulation (DYNTACS(X)) Fire Support Operation Models. Ohio State University, FR71-3A, October 1971.

This volume documents a revised aerial platform module, more accepted than the one developed for the DYNCOM version. The companion volume, FY71-3B, contains all flow charts and data blocks for DYNTACS(X).

ANNEX B--II

ANNOTATED BIBLIOGRAPHY FOR IUA

1. PREPARATION OF THE TERRAIN AND TACTICAL DATA BASE AND EXECUTION OF THE TERRAIN AND MOBILITY PROCESSORS.

a. US Army Combat Developments Command, Tank-Antitank and Assault Weapons Requirements Study, Phase III, Volume XIII, appendix [illegible] to annex L, AD849891L, December 1968.

The document contains the terrain and tactical analysis conducted during the TATAWS study for the IUA runs. It also provides several examples of the types of data needed to describe the terrain and the tactics played by attackers and defenders in the model.

b. ______, ______, Volume XXI, appendix VII to annex L, AD849897L, December 1968.

This report contains examples of the Red and Blue force compositions and tactical maneuvers for both forces used in the TATAWS runs. A complete listing of the critical range lines describing the model's tactical options for both attacker and defenders can also be found in the report.

2. DOCUMENTATION OF THE IUA COMBAT MODEL.

US Army Combat Developments Command, Tank-Antitank and Assault Weapons Requirements Study, Phase III, Volume XVIII, Tabs C and D of appendix V to annex L, AD849895L, December 1968.

The document contains flow diagrams of all programs and subroutines found in the IUA combat model. Flow diagrams of subroutines in the terrain and mobility models are not provided. Input card formats for the entire (terrain, mobility, and combat) data base are also provided.

3. GENERAL MODEL DOCUMENTATION.

a. US Army Combat Developments Command, Tank-Antitank and Assault Weapons, Phase III, Volume XVII, Tab B of appendix V to annex L, AD849894L, December 1968.

The document contains a table of all key model variable names and a description of their content. The variable names are grouped by subroutine for the terrain, mobility, combat, and postprocessor programs.

b. ______, ______, Volume XVI, Tab A of appendix V to annex L, AD849893L, December 1968.

The document contains a listing of all IUA programs. This includes the terrain processor, mobility processor, IUA combat model, output event processor, and the utility routines necessary to load the constant data deck.

c. Lockheed Missiles and Space Company, Instructions for Applying IUA Program to US Army CDC 3300, N-54-68-1, Sunnyvale, California, November 1968.

The document serves as an operator's manual, providing deck structures for exercising the model on the CDC 3300. The data base file structures used by the terrain processor, mobility processor, IUA combat model, and output event processor are also described.

d. US Army Combined Arms Combat Developments Activity, Procedures Guide for the Individual Unit Action (IUA) Model on the Fort Leavenworth Data Processing Installation CDC 6500 Computer System, Combat Operations Analysis Directorate Technical Report TR2-73, November 1973.

The document is an operator's manual, providing deck structure for exercising the model on the CDC 6500. It also contains a description of the input data card formats for the terrain processor, mobility processor, and IUA combat model.

4. DATA BASES FOR IUA COMBAT MODEL.

a. Goulet, B.N., Report on Support Provided by Army Material Systems Analysis Agency/Ballistic Research Laboratories for TATAWS III Computer Simulations (U), Army Material Systems Analysis Agency Technical Memorandum No. 20, Aberdeen Proving Ground, Maryland, January 1969, (SECRET).

Probabilities of hit and kill, and firing and flight times for weapons and rounds used in the TATAWS III IUA combat model runs can be found in this document. Much of the data is in the card format required by the IUA model.

b. Lockheed Missiles and Space Company, Report of Simulation Support for the Evaluation of Candidate Tank Considerations Using the Individual Unit Action (IUA) Simulation Model (U), LMSC-D009535, Sunnyvale, California, December 1972, CONFIDENTIAL.

The document contains probabilities of hit and kill for weapons and rounds used in the Tank Configuration study. Also included are distributions describing the time required by crews to detect a target. All data are in the format required by the IUA model.

ANNEX B--III

ANNOTATED BIBLIOGRAPHY FOR CARMONETTE

1. General Research Corporation, CARMONETTE, Volume I--General Description, McLean, Virginia, 1974.
This is an executive level overview of the model. It also contains, in the space of a dozen pages, the only available discussion of the mathematical basis of the model.

2. ______, CARMONETTE, Volume II--Data Preparation and Output Guide, McLean, Virginia, 1974.
This volume is oriented to the individuals responsible for developing CARMONETTE input data. Coding forms and instructions for preparing the data are included, with illustrative examples. Discussions of the ramifications of selected data items, many of which are of a subjective or aggregated nature, are also included.

3. ______, CARMONETTE, Volume III--Technical Documentation, McLean, Virginia, 1974.
This volume is programer oriented. It documents detailed logical flow, data layout within the computer, and mechanical operating procedures.

APPENDIX C

REFERENCES

APPENDIX C

REFERENCES

1. Tactical Effectiveness Testing of Antitank Missiles (USACDEC Experiment 11.8), US Army Combat Developments Experimentation Command, Fort Ord, California 93941.

Published in nine volumes:

a. Volume I - Executive Summary, Feb 1974.

b. Volume II - Final Report, Phase IE, Oct 1972. (Intervisibility, Europe)

c. Volume III - Final Report, Phase IL, Feb 1973. (Intervisibility, Fort Lewis, Washington)

d. Volume IV - Final Report, Phases IA, B, C, Feb 1973. (Intervisibility at HLMR, Cal./Evasive maneuvers/ Detection/Acquisition/Handoff)

e. Volume V - Data Package, Phases IA, B, C, Feb 1973.

f. Volume VI - Final Report, Phase II, Sep 1973. (Acquisition/Exposure/Evasive targets/Tracking)

g. Volume VII - Data Package, Phase II, Sep 1973.

h. Volume VIII - Final Report, Phase III, Feb 1974. (Dynamic battle play)

i. Volume IX - Data Package, Phase III, Feb 1974.

2. TETAM Effectiveness Evaluation, Directorate of Combat Operations Analysis, US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027.

Published in three volumes:

a. Technical Memorandum TM 2-73, Phase I, Nov 1973.

b. Technical Memorandum TM 1-74, Phase II, Apr 1974.

c. Technical Memorandum TM 3-74, Phase III, Jul 1974.

3. TETAM Model Verification Plan, Technical Report TR 3-75, Directorate of Combat Operations Analysis, US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, Nov 1973.

4. Notes from the DYNTACS(X) Training Class Conducted at Fort Leavenworth, Kansas, Computer Sciences Corporation, Falls Church, Virginia 22046, Jan 1974.

5. TETAM Model Verification Study, Volume I--Representation of Intervisibility, Initial Comparisons, Directorate of Combat Operations Analysis, US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, to be published.

6. TETAM Model Verification Study, Volume II--Modified Representations of Intervisibility, Directorate of Combat Operations Analysis, US Army Combined Arms Combat Developments Activity, Fort Leavenworth, Kansas 66027, to be published.

7. Terrain Site Analysis and Comparison for Tactical Effectiveness Testing of Antitank Missiles, Draft Report, US Army Engineer Waterways Experiment Station, Vicksburg, Mississippi, Sep 1973.

8. The Effects of Measurement Resolution on the Descriptions of Target Visibility, Technical Memorandum 11074, US Army Human Engineering Laboratory, Aberdeen Proving Ground, Maryland, Apr 1974.

9. USACDEC Hellfire Rapid, Ripple, and Indirect Fire Field Experiment, Phase IV A, CACDA Terrain Analysis, Aug 75, unpublished.

10. Tactical Effectiveness Testing of Antitank Missiles (USACDEC Experiment 11.8), US Army Combat Developments Experimentation Command, Fort Ord, California 93941. Final Report, Addendum I to Volume III (U). SECRET

11. Data Requirements for Phase III, TETAM (U). Letter, Morgan G. Smith, US Army Materiel Systems Analysis Agency, 2 October 1973. CONFIDENTIAL

12. Report of Simulation Support for the Evaluation of Candidate Tank Configurations Using the IUA Simulation Model (U). Volume I, Sections 1-4. CONFIDENTIAL

APPENDIX D

FIELD EXPERIMENT TRIALS

(to be published separately)

APPENDIX E

DETAILED COMPARISON FIRING DATA

APPENDIX E

DETAILED COMPARISON FIRING DATA

E-1. INTRODUCTION. The detailed trial comparisons carried out for TETAM model verification work centered upon individual weapons firings and engagements as observed in selected field experiment trials and the firings generated by combat simulations (DYNTACS and IUA) when the models were run with input data depicting the same initial situations and movement traces observed in the field. The individual firing information used for these comparisons is contained in this appendix.

E-2. CONTENTS. Firing data from the simulations and from the field for trial 34 is contained in annex E-I and for trial 96 in annex E-II.

E-3. DATA FORMAT.

a. The layout for firing data is illustrated in table E-I-1a. One such table is provided for each field trial and for each model replication of a trial. Entries are in the chronological order in which weapon firing took place in the field or simulation. Data for each firing is composed of the following nine entries:

(1) Fire time, the time of firing measured in seconds from the point of time at which field trial data begins. Recorded locations at this point in time were taken as initial positions for the model runs; thus, field and model data should be on the same time scale.

(2) Firing weapon - player ID, a three-letter mnemonic identifying the type of firing weapon and a two-digit numeric identifying the individual vehicle. Identification is consistent between the field data and model data; i.e., SHL 20 identifies the same individual weapon for both field and model data. Mnemonics used are: SHL-Shillelagh, TOW-TOW, DGN-DRAGON, T62-threat force tank, ATM-threat force antitank guided missile carrier, ICV-threat force armored personnel carrier.

(3) Firing weapon - location, UTM coordinates at time of firing. For the field trial this is an estimate based on firing time and interpolation of locations, which were available typically at 60-second increments.

(4) Target weapon - player ID, same format as firer weapon ID. In the event of an unpaired firing, which could occur only in the field, the target of a firing is unknown and this field is blank.

(5) Target weapon - location, UTM coordinates at firing time for DYNTACS, impact time for IUA and field. Field positions is interpolated from available data. Entry is blank for unpaired firing.

(6) Target weapon - velocity, target speed at firing time in meters per second. Estimated from 60-second increment location data for the field. Blank for unpaired firings. Note that there is no requirement for firing weapons velocity because the field trials and simulations were conducted to allow firing only by stationary weapons.

(7) Range, target to firer horizontal distance at time of firing.

(8) Impact time, time of round impact, measured in seconds from the same reference point as firing times.

(9) Result of the firing. Entries are generally self-explanatory: SURVIVE; M KILL - mobility kill; F KILL - firepower kill; M + F KILL - mobility and firepower kill; ICV KILL - mobility kill, which was only type of kill possible to an ICV; PRV KILL - assessment against vehicle that has already sustained M + F KILL; UNPAIRED - unpaired firing, target unknown, can only occur in the field; LOS LOST - line of sight was lost between firing and impact or did not exist at impact (depending on particular model treatment), no target assessment.

ANNEX E-I

TRIAL 34 FIRING DATA

1. This annex contains firing data for Trial 34.

2. The following tables are provided.

Number	Title
E-I-1a	Firing Data from DYNTACS Trial 34 Base Case
E-I-1b	Firing Data from DYNTACS Trial 34 Excursion
E-I-2a	Firing Data from IUA Trial 34 Base Case
E-I-2b	Firing Data from IUA Trial 34 Excursion
E-I-3	Firing Data from TETAM Phase III Field Trial 34

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
397	SHL-20	5636577755	T62- 2	5406079169	6.3	2704	411	M+F KILL
431	TOW-18	5580677808	ICV-15	5441179170	5.5	1950	440	ICV KILL
439	TOW-19	5495078020	T62- 8	5417379270	5.9	1471	446	LOS LOST
478	ATM-10	5418378746	SHL-20	5636577755	0.0	2397	493	M KILL
480	ATM-11	5411078791	SHL-2	5636577755	0.0	2482	495	M+F KILL
538	TOW-18	5580677808	T62- 4	5465979054	.5	1694	545	SURVIVE
552	TOW-19	5495078020	T62- 6	5475378496	5.8	515	555	M+F KILL
569	TOW-18	5580677808	T62- 4	5466979042	.5	1679	577	M+F KILL
577	DRG-24	5536477984	T62- 9	5495078426	5.5	606	583	SURVIVE
605	DRG-24	5536477984	T62- 9	5495078426	5.5	606	611	M KILL
609	TOW-19	5495078020	T62- 9	5495078426	0.0	406	610	SURVIVE
622	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	630	SURVIVE
632	DRG-24	5536477984	T62- 9	5495078426	0.0	606	639	SURVIVE
634	TOW-19	5495078020	T62- 9	5495078426	0.0	406	636	SURVIVE
639	TOW-18	5580677808	ICV-13	5496278645	5.5	1190	644	LOS LOST
642	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	650	SURVIVE
657	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	665	SURVIVE
660	TOW-19	5495078020	T62- 9	5495078426	0.0	406	662	M+F KILL
686	TOW-19	5495078020	ICV-13	5515978428	5.5	464	688	ICV KILL

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
369	TOW-19	5495078020	T62- 5	5405679375	5.8	1617	377	M+F KILL
401	TOW-19	5495078020	ICV-13	5408979448	5.3	1667	408	SURVIVE
432	TOW-18	5580677808	ICV-15	5444479151	5.5	1912	440	SURVIVE
462	SHL-20	5636577755	T62- 8	5420279200	5.3	2601	474	M+F KILL
464	TOW-18	5580677808	ICV-15	5455579072	5.5	1779	472	LOS LOST
481	ATM-10	5420678726	SHL-20	5636577755	0.0	2368	495	M+F KILL
486	SHL-20	5636577755	ICV-15	5466878952	5.5	2077	499	ICV KILL
529	TOW-18	5580677608	ICV-13	5453779063	5.5	1785	537	ICV KILL
574	TOW-19	5495078020	T62- 1	5483978664	5.5	653	577	SURVIVE
584	DRG-24	5536477984	T62- 9	5495078426	5.5	606	590	F KILL
601	TOW-19	5495078020	T62- 1	5493778570	5.5	550	603	SURVIVE
604	DRG-24	5536477984	T62- 9	5495078426	5.5	606	611	LOS LOST
621	T62- 6	5495078295	TOW-19	5495078020	0.0	275	621	M+F KILL
626	DRG-24	5536477984	T62- 9	5495078426	0.0	606	633	M+F KILL
656	ATM-10	5432978617	DRG-24	5536477984	0.0	1213	663	SURVIVE

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
367	TOW-19	5495078020	ICV-15	5417279351	5.8	1542	374	SURVIVE
433	TOW-18	5580677808	ICV-15	5441179170	5.5	1950	442	ICV KILL
433	SHL-20	5636577755	T62- 1	5429879191	5.8	2517	445	SURVIVE
458	SHL-20	5636577755	T62- 1	5441579076	5.5	2355	470	M KILL
475	ATM-10	5418378746	SHL-20	5636577755	0.0	2397	489	SURVIVE
483	SHL-20	5636577755	T62- 1	5441579076	0.0	2355	495	F KILL
497	ATM-10	5418378746	SHL-20	5636577755	0.0	2397	511	M+F KILL
511	TOW-18	5580677808	T62- 4	5450079266	.3	1957	520	SURVIVE
518	DRG-24	5536477984	T62- 9	5472278621	5.8	905	528	LOS LOST
533	ATM-11	5411078791	DRG-24	5536477984	0.0	1491	542	SURVIVE
541	DRG-24	5536477984	T62- 9	5472278621	5.8	905	551	SURVIVE
544	TOW-18	5580677808	T62- 4	5451079255	.5	1942	553	M+F KILL
548	ATM-10	5420678723	DRG-24	5536477984	0.0	1374	556	SURVIVE
551	ATM-11	5411078791	DRG-24	5536477984	0.0	1491	560	SURVIVE
555	TOW-19	5495078020	T62- 9	5484878514	5.5	504	557	M+F KILL
562	ATM-10	5420678723	DRG-24	5536477984	0.0	1374	571	SURVIVE
568	ATM-11	5411078791	DRG-24	5536477984	0.0	1491	577	SURVIVE
581	TOW-19	5495078020	T62- 6	5486978379	5.8	368	583	SURVIVE
586	ATM-10	5420678723	DRG-24	5536477984	0.0	1374	594	SURVIVE
599	ATM-10	5420678723	DRG-24	5536477984	0.0	1374	608	M+F KILL
608	TOW-19	5495078020	T62- 6	5498578260	5.5	244	609	M+F KILL
653	TOW-19	5495078020	ICV-13	5507078533	5.5	527	656	SURVIVE
704	TOW-19	5495078020	ICV-13	5513478414	5.5	458	706	ICV KILL

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
369	SHL-20	5636577755	T62- 9	5399679217	5.8	2783	383	LOS LOST
377	TOW-19	5495078020	ICV-15	5417279351	5.8	1542	384	LOS LOST
391	SHL-20	5636577755	T62- 9	5413679112	5.8	2610	404	SURVIVE
421	SHL-20	5636577755	T62- 9	5425479008	5.5	2447	433	LOS LOST
451	TOW-18	5580677808	ICV-15	5443879157	5.5	1921	459	SURVIVE
476	SHL-20	5636577755	ICV-15	5465278959	5.5	2086	487	SURVIVE
482	ATM-10	5420778720	SHL-20	5635577755	0.0	2364	495	M KILL
483	TOW-18	5580677808	ICV-15	5454879078	5.5	1786	492	LOS LOST
501	ATM-10	5420778720	SHL-20	5635577755	0.0	2364	515	M+F KILL
516	SHL-20	5636577755	ICV-15	5465278959	5.5	2086	526	LOS LOST
547	TOW-19	5495078020	T62- 6	5474078508	5.5	532	550	M+F KILL
574	TOW-19	5495078020	ICV-15	5495278645	5.5	625	577	ICV KILL
588	DRG-24	5536477984	T62- 9	5495078426	5.5	606	594	SURVIVE
614	ATM-10	5427978652	DRG-24	5535477984	0.0	1273	622	SURVIVE
619	TOW-19	5495078020	T62- 9	5505278339	5.5	335	621	F KILL
629	ATM-10	5427978652	DRG-24	5535477984	0.0	1273	637	SURVIVE
641	DRG-24	5536477984	T62- 9	5505278339	0.0	472	645	SURVIVE
643	ATM-10	5427978652	DRG-24	5535477984	0.0	1273	650	SURVIVE
645	TOW-19	5495078020	T62- 9	5505278339	0.0	335	647	SURVIVE
662	TOW-18	5580677808	T62- 4	5454979209	.5	1882	671	M+F KILL
662	DRG-24	5536477984	T62- 9	5505278339	0.0	472	667	SURVIVE
671	TOW-19	5495078020	T62- 9	5505278339	0.0	335	672	M+F KILL
702	TOW-19	5495078020	T62- 2	5512078281	5.5	312	704	M+F KILL

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
339	SHL-20	5636577755	T62- 9	5391579320	5.8	2907	353	SURVIVE
366	SHL-20	5636577755	T62- 9	5399679217	5.8	2783	380	LOS LOST
369	TOW-19	5495078020	T62- 5	5406679375	5.8	1617	376	M+F KILL
388	SHL-20	5636577755	T62- 9	5412879118	5.5	2619	401	M+F KILL
421	SHL-20	5636577755	T62- 6	5420979049	5.5	2515	433	LOS LOST
453	TOW-18	5580677808	ICV-15	5443679155	5.5	1921	462	SURVIVE
466	ATM-11	5426678965	SHL-20	5636577755	0.0	2422	481	M KILL
477	SHL-20	5636577755	ATM-10	5418378746	0.0	2397	488	M KILL
486	TOW-18	5580677808	ICV-15	5455179047	5.5	1757	494	LOS LOST
487	ATM-11	5426678965	SHL-20	5636577755	0.0	2422	502	M KILL
506	SHL-20	5636577755	ATM-10	5418378746	0.0	2397	518	M KILL
507	ATM-11	5426678965	SHL-20	5636577755	0.0	2422	522	SURVIVE
524	ATM-10	5418378746	SHL-20	5636577755	0.0	2397	539	M+F KILL
563	TOW-19	5495078020	T62- 6	5476678482	5.5	497	565	M+F KILL
616	TOW-19	5495078020	ICV-13	5483878717	5.7	706	619	ICV KILL
623	DRG-24	5536477984	T62- 2	5488178485	5.8	696	631	SURVIVE
629	TOW-18	5580677808	ICV-15	5519178406	5.5	858	633	ICV KILL
644	DRG-24	5536477984	T62- 2	5500678378	5.5	532	649	M+F KILL
666	ATM-10	5418378746	DRG-24	5536477984	0.0	1406	674	SURVIVE
669	TOW-19	5495078020	T62- 1	5527078246	5.5	392	671	M+F KILL
677	ATM-11	5428778801	DRG-24	5536477984	0.0	1352	685	SURVIVE
681	ATM-10	5418378746	DRG-24	5536477984	0.0	1406	690	SURVIVE
692	ATM-11	5428778801	DRG-24	5536477984	0.0	1352	700	SURVIVE
699	ATM-10	5418378746	DRG-24	5536477984	0.0	1406	708	SURVIVE
711	ATM-11	5428778801	DRG-24	5536477984	0.0	1352	719	SURVIVE
717	ATM-10	5418378746	DRG-24	5536477984	0.0	1406	726	SURVIVE
718	TOW-19	5495078020	T62- 8	5522778253	5.5	362	719	M+F KILL
734	ATM-10	5418378746	DRG-24	5536477984	0.0	1406	743	SURVIVE
743	ATM-10	5418378746	DRG-24	5536477984	0.0	1406	757	SURVIVE
761	ATM-11	5438478669	DRG-24	5536477984	0.0	1196	769	SURVIVE

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
762	AT4-10	5418378746	DRG-24	5536477984	0.0	1406	770	SURVIVE
774	AT4-11	5438478569	DRG-24	5536477984	0.0	1196	781	SURVIVE
775	AT4-10	5418378746	DRG-24	5535477984	0.0	1406	784	SURVIVE
787	AT4-11	5436478569	DRG-24	5535477984	0.0	1146	794	SURVIVE
789	T34-19	5495078020	T62- 4	5480078559	5.5	560	792	SURVIVE
789	AT4-10	5418378746	DRG-24	5535477984	0.0	1406	797	SURVIVE
816	T34-19	5495078020	T62- 4	5480078559	5.5	560	818	SURVIVE

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
378	TOW-19	5495078020	T62- 5	5406679375	5.8	1617	385	M+F KILL
429	SHL-20	5636577755	T62- 1	5429179197	5.5	2526	442	M+F KILL
430	TOW-18	5580677808	ICV-15	5441179170	5.8	1950	439	ICV KILL
450	SHL-20	5636577755	T62- 4	5438079067	5.8	2380	461	SURVIVE
463	TOW-18	5580677808	ICV-13	5445679155	5.8	1901	471	ICV KILL
474	SHL-20	5636577755	T62- 4	5448078936	5.5	2225	485	M+F KILL
481	ATM-10	5421178719	SHL-20	5636577755	0.0	2360	495	M+F KILL
539	TOW-19	5495078020	T62- 6	5471978530	5.8	560	542	SURVIVE
566	TOW-19	5495078020	T62- 6	5471978530	5.8	560	569	SURVIVE
589	DRG-24	5536477984	T62- 9	5497978400	5.5	567	595	SURVIVE
593	TOW-19	5495078020	T62- 6	5483578413	5.5	409	594	SURVIVE
608	DRG-24	5536477984	T62- 9	5508278313	5.5	433	613	LOS LOST
610	T62- 6	5493078317	TOW-19	5495078020	0.0	297	610	M+F KILL
687	DRG-24	5536477984	T62- 6	5506978176	.5	352	691	SURVIVE

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
344	TOW-19	5495078020	ICV-13	5399979532	4.8	1786	352	ICV KILL
372	SHL-20	5636577755	T62- 5	5406679375	5.8	2812	385	SURVIVE
376	TOW-19	5495078020	T62- 5	5405679375	5.8	1617	383	SURVIVE
397	SHL-20	5636577755	T62- 5	5413179256	5.5	2651	410	M KILL
407	TOW-19	5495078020	T62- 5	5413179256	5.5	1456	414	SURVIVE
423	SHL-20	5636577755	T62- 5	5413179256	0.0	2651	436	M+F KILL
444	SHL-20	5636577755	T62- 1	5433879103	5.5	2393	456	SURVIVE
468	SHL-20	5636577755	T62- 1	5450678988	5.5	2231	479	SURVIVE
487	SHL-20	5636577755	T62- 1	5450678988	5.5	2231	498	M+F KILL
488	ATM-10	5414478799	SHL-20	5635577755	0.0	2454	503	M+F KILL
586	TOW-19	5495078020	ICV-15	5493478623	5.5	604	589	ICV KILL
593	DRG-24	5536477984	T62- 9	5497278406	5.5	576	599	SURVIVE
613	DRG-24	5536477984	T62- 9	5507578319	5.5	442	617	LOS LOST
617	T62- 6	5493078317	TOW-19	5495078020	0.0	297	617	M+F KILL
634	ATM-10	5423178700	DRG-24	5535477984	0.0	1340	642	SURVIVE
651	ATM-10	5423178700	DRG-24	5535477984	0.0	1340	659	SURVIVE
666	ATM-10	5423178700	DRG-24	5535477984	0.0	1340	674	SURVIVE
675	DRG-24	5536477984	T62- 6	5506278182	.5	361	679	SURVIVE
693	DRG-24	5536477984	T62- 6	5505978176	.5	352	697	M+F KILL
717	ATM-10	5425578678	DRG-24	5535477984	0.0	1306	725	SURVIVE

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
367	TOW-19	5495078020	T62- 5	5405679375	5.8	1617	375	M+F KILL
436	SHL-20	5636577755	T62- 8	5411079290	4.0	2728	449	SURVIVE
46[illegible]	SHL-20	5636577755	T62- 8	5420279200	5.3	2601	473	M+F KILL
481	SHL-20	5636577755	ICV-15	5466278959	5.5	2066	492	ICV KILL
488	ATM-10	5418378746	SHL-20	5636577755	0.0	2397	502	SURVIVE
511	ATM-10	5418378746	SHL-20	5636577755	0.0	2397	525	M+F KILL
518	TOW-18	5580677808	ICV-13	5453179070	5.5	1795	526	ICV KILL
582	TOW-19	5495078020	T62- 6	5474078508	5.5	532	584	M+F KILL
592	DRG-24	5536477984	T62- 9	5487078495	5.5	710	599	M+F KILL
619	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	627	SURVIVE
627	TOW-19	5495078020	T62- 2	5480178517	5.5	519	630	M+F KILL
637	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	645	SURVIVE
638	ATM-11	5438978831	TOW-19	5495078020	0.0	985	644	M KILL
651	ATM-10	5425678681	DRG-24	5534477984	0.0	1308	659	SURVIVE
656	ATM-11	5438978831	TOW-19	5495078020	0.0	985	662	M KILL
667	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	675	SURVIVE
683	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	691	SURVIVE
697	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	704	SURVIVE

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
337	SHL-20	5636577755	T62- 9	5391579320	5.8	2907	351	SURVIVE
359	SHL-20	5636577755	T62- 9	5399679217	5.8	2783	373	M+F KILL
381	SHL-20	5636577755	T62- 6	5411879149	5.5	2644	394	M+F KILL
434	SHL-20	5636577755	T62- 1	5429179197	5.5	2526	446	SURVIVE
435	TOW-18	5580677808	T62- 4	5430079458	0.0	2234	446	M+F KILL
463	SHL-20	5636577755	T62- 1	5440979082	5.5	2364	475	SURVIVE
487	ATM-10	5418378746	SHL-20	5636577755	0.0	2397	502	M+F KILL
489	SHL-20	5636577755	T62- 1	5450678988	5.5	2231	500	SURVIVE
568	TOW-19	5495078020	T62- 1	5483978664	5.5	653	571	SURVIVE
619	TOW-19	5495078020	ICV-15	5507678526	5.5	522	621	ICV KILL
668	TOW-19	5495078020	T62- 2	5522978203	5.5	334	670	M+F KILL
67	ATM-11	5443878797	TOW-19	5495078020	0.0	930	676	SURVIVE
683	ATM-11	5443878797	TOW-19	5495078020	0.0	930	688	SURVIVE
693	ATM-11	5443878797	TOW-19	5495078020	0.0	930	699	M+F KILL

Table E-I-1a

FIRING DATA FROM DYNTACS TRIAL 34 BASE CASE

DYN TRIAL 34 REP 10

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
376	TOW-19	5495078020	T62- 1	5407879403	5.8	1634	383	M+F KILL
407	TOW-19	5495078020	T62- 8	5408679387	5.5	1617	415	M+F KILL
450	TOW-18	5580677808	ICV-15	5444479151	5.5	1912	458	ICV KILL
465	SHL-20	5636577755	T62- 5	5437879041	5.5	2367	477	M+F KILL
502	TOW-18	5580677808	ICV-13	5448779124	5.5	1864	510	SURVIVE
504	ATM-10	5420678723	SHL-20	5635577755	0.0	2366	519	SURVIVE
517	SHL-20	5636577755	ICV-13	5458979036	5.5	2190	527	SURVIVE
524	ATM-10	5420678723	SHL-20	5636577755	0.0	2366	538	M+F KILL
549	TOW-19	5495078020	T62- 9	5485478508	5.8	497	551	M+F KILL
575	TOW-19	5495078020	T62- 6	5474778503	5.8	523	577	SURVIVE
590	DRG-24	5536477984	T62- 6	5486378384	5.5	642	597	SURVIVE
601	TOW-19	5495078020	T62- 6	5486378384	5.5	375	603	M KILL
614	ATM-10	5425478677	DRG-24	5535477984	0.0	1309	622	SURVIVE
616	DRG-24	5536477984	T62- 6	5486378384	0.0	642	623	M+F KILL
630	ATM-10	5425478677	DRG-24	5535477984	0.0	1309	638	SURVIVE
646	ATM-10	5425478677	DRG-24	5536477984	0.0	1309	654	SURVIVE
656	TOW-19	5495078020	T62- 2	5512678276	5.5	311	657	M+F KILL
699	TOW-19	5495078020	ICV-13	5532578266	5.5	449	701	ICV KILL
771	TOW-19	5495078020	ATM-11	5473378566	4.9	587	774	M+F KILL

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
433	SHL-20	5636577755	T62- 5	5427579158	5.8	2517	445	M+F KILL
458	SHL-20	5636577755	T62- 1	5433879103	5.8	2393	470	M+F KILL
467	TOW-19	5580677808	T62- 4	5445479136	5.5	1888	476	M+F KILL
475	AT4-10	5418378746	SHL-20	5635577755	0.0	2397	490	M+F KILL
546	TOW-19	5495078020	T62- 9	5469278647	5.8	677	549	M+F KILL
605	TOW-19	5495078020	T62- 6	5495778289	5.5	269	606	M+F KILL
640	DRG-24	5536477984	T62- 2	5510278296	5.5	408	644	LOS LOST
644	AT4-10	5430978642	DRG-24	5536477984	0.0	1242	652	SURVIVE
651	TOW-19	5495078020	T62- 2	5510278296	5.5	316	652	M+F KILL
657	AT4-10	5430978642	DRG-24	5536477984	0.0	1242	664	SURVIVE
674	AT4-10	5430978642	DRG-24	5535477984	0.0	1242	681	SURVIVE

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
369	TOW-19	5495078020	T62- 5	5405679375	5.8	1617	377	M+F KILL
429	TOW-19	5495078020	T62- 8	5411079290	4.0	1522	436	SURVIVE
430	SHL-20	5636577755	T62- 8	5411079290	4.0	2728	444	SURVIVE
452	SHL-20	5636577755	T62- 8	5422879175	5.5	2566	466	SURVIVE
474	SHL-20	5636577755	T62- 8	5432179085	5.3	2439	486	M+F KILL
474	ATM-10	5418378746	SHL-20	5636577755	0.0	2397	488	M+F KILL
57[illegible]	DRG-24	5536477984	T62- 9	5485478508	5.8	731	578	SURVIVE
575	TOW-19	5495078020	T62- 9	5485478508	5.8	497	578	SURVIVE
584	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	592	SURVIVE
597	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	605	SURVIVE
602	TOW-19	5495078020	T62- 9	5497978400	5.5	382	603	M+F KILL
613	ATM-10	5425678681	DRG-24	5536477984	0.0	1308	621	SURVIVE
623	T62- 6	5495078295	TOW-19	5495078020	0.0	275	623	M+F KILL
628	DRG-24	5536477984	T62- 6	5495078295	5.5	517	634	SURVIVE
652	DRG-24	5536477984	T62- 6	5506678178	5.5	355	656	M+F KILL
661	ATM-10	5428178659	DRG-24	5536477984	0.0	1276	668	SURVIVE
674	ATM-10	5428178659	DRG-24	5536477984	0.0	1276	682	SURVIVE
688	ATM-10	5428178659	DRG-24	5536477984	0.0	1276	696	SURVIVE

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
405	SHL-20	5636577755	T62- 5	5415179289	5.8	2685	418	SURVIVE
407	TOW-19	5495078020	T62- 5	5415179289	5.8	1494	413	LOS LOST
426	SHL-20	5636577755	T62- 5	5427579158	5.8	2517	438	SURVIVE
442	TOW-18	5580677808	T62- 4	5444579298	7.2	2018	451	SURVIVE
452	SHL-20	5636577755	T62- 5	5438479034	5.5	2358	463	M+F KILL
475	TOW-18	5580677808	T62- 4	5444579298	0.0	2018	484	M+F KILL
483	SHL-20	5636577755	T62- 1	5450678988	5.5	2231	491	SURVIVE
480	ATM-10	5421178719	SHL-20	5636577755	0.0	2360	494	M+F KILL
578	TOW-19	5495078020	T62- 6	5475778481	5.5	496	580	SURVIVE
581	DRG-24	5536477984	T62- 9	5495078426	5.5	606	587	SURVIVE
603	DRG-24	5536477984	T62- 9	5495078426	5.5	606	610	LOS LOST
604	TOW-19	5495078020	T62- 6	5485378384	5.5	375	606	SURVIVE
623	DRG-24	5536477984	T62- 9	5507578319	5.5	442	628	LOS LOST
630	TOW-19	5495078020	T62- 6	5497878267	5.5	249	631	M+F KILL
675	DRG-24	5536477984	T62- 2	5483878364	.5	549	682	SURVIVE
685	TOW-19	5495078020	T62- 9	5518978222	.5	313	687	M+F KILL
685	ATM-10	5435978588	DRG-24	5535477984	0.0	1172	692	SURVIVE
705	DRG-24	5536477934	T62- 2	5485378366	.5	638	712	SURVIVE

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
369	SHL-20	5636577755	T62- 9	5399679217	5.8	2783	383	LOS LOST
435	SHL-20	5636577755	T62- 9	5426479008	5.5	2447	447	LOS LOST
484	SHL-20	5636577755	T62- 4	5450079266	.3	2400	496	M+F KILL
515	ATM-10	5423078695	SHL-20	5636577755	0.0	2334	529	SURVIVE
537	ATM-10	5423078695	SHL-20	5636577755	0.0	2334	551	M KILL
559	ATM-10	5423078695	SHL-20	5636577755	0.0	2334	573	SURVIVE
560	DRG-24	5536477984	T62- 9	5482478533	5.5	770	568	SURVIVE
572	T3M-19	5495078020	T62- 9	5482478533	5.5	528	574	M+F KILL
595	SHL-20	5636577755	ATM-10	5425178670	1.1	2304	606	M KILL
598	T3M-19	5495078020	T62- 6	5483578413	5.5	409	600	M+F KILL
641	ATM-10	5425178670	SHL-20	5636577755	0.0	2304	655	M+F KILL
642	T3M-19	5495078020	T62- 2	5488578465	5.5	449	644	SURVIVE
645	DRG-24	5536477984	T62- 2	5488578465	5.5	678	653	SURVIVE
668	T3M-19	5495078020	T62- 2	5488578465	5.5	449	671	SURVIVE
670	DRG-24	5536477984	T62- 2	5499678387	5.5	546	676	LOS LOST
693	ATM-10	5425178670	DRG-24	5536477984	0.0	1307	701	SURVIVE
695	T3M-19	5495078020	T62- 2	5499678387	5.5	370	696	SURVIVE
709	ATM-10	5425178670	DRG-24	5536477984	0.0	1307	717	SURVIVE
725	ATM-10	5425178670	DRG-24	5536477984	0.0	1307	733	SURVIVE

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
339	SHL-20	5636577755	T62- 9	5391579320	5.8	2907	353	SURVIVE
366	SHL-20	5636577755	T62- 9	5399679217	5.8	2783	380	LOS LOST
369	T34-19	5495078020	T62- 5	5406679375	5.8	1617	376	M+F KILL
388	SHL-20	5636577755	T62- 9	5412879118	5.5	2619	401	M+F KILL
421	SHL-20	5636577755	T62- 6	5420979049	5.5	2515	433	LOS LOST
488	AT4-10	5418378746	SHL-20	5636577755	0.0	2397	503	M+F KILL
573	T34-19	5495078020	T62- 6	5474678504	5.8	525	576	SURVIVE
600	T34-19	5495078020	T62- 6	5486878380	5.8	369	602	M+F KILL
651	T34-19	5495078020	T62- 2	5497678403	5.5	384	652	M+F KILL
686	AT4-10	5433778523	DRG-24	5535477984	0.0	1210	693	SURVIVE

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
378	TOW-19	5495078020	T62- 5	5405679375	5.8	1617	885	M+F KILL
429	SHL-20	5636577755	T62- 1	5429179197	5.5	2526	442	M+F KILL
452	SHL-20	5636577755	T62- 4	5438079067	5.8	2380	464	SURVIVE
472	SHL-20	5636577755	T62- 4	5448078936	5.5	2225	483	SURVIVE
481	AT4-10	5421178719	SHL-20	5636577755	0.0	2360	495	M+F KILL
548	TOW-19	5495078020	T62- 6	5474778503	5.8	523	550	SURVIVE
574	TOW-19	5495078020	T62- 6	5474778503	5.8	523	577	SURVIVE
577	DRG-24	5536477984	T62- 9	5497978400	5.5	567	583	SURVIVE
601	TOW-19	5495078020	T62- 6	5486378384	5.5	375	602	M+F KILL
626	TOW-19	5495078020	T62- 2	5475778433	5.7	455	628	M+F KILL
626	AT4-10	5430978631	DRG-24	5535477984	0.0	1237	634	SURVIVE
640	AT4-10	5430978631	DRG-24	5536477984	0.0	1237	647	SURVIVE
652	AT4-10	5430978631	DRG-24	5535477984	0.0	1237	660	SURVIVE
670	TOW-19	5495078020	T62- 9	5521978196	.5	322	672	M+F KILL
696	TOW-19	5495078020	T62- 8	5515578357	5.5	395	698	SURVIVE

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
380	T34-19	5495078020	T62- 5	5405679375	5.8	1617	387	M+F KILL
388	SHL-20	5636577755	T62- 5	5405679375	5.8	2812	402	PRV KILL
415	SHL-20	5636577755	T62- 1	5429179197	5.5	2526	428	M+F KILL
466	SHL-20	5636577755	T62- 4	5444778961	5.5	2265	477	M+F KILL
489	SHL-20	5636577755	T62- 8	5435379128	5.5	2428	501	SURVIVE
508	ATM-10	5420678723	SHL-20	5635577755	0.0	2366	522	SURVIVE
509	SHL-20	5636577755	T62- 8	5443079013	5.5	2266	520	SURVIVE
532	SHL-20	5636577755	T62- 8	5457778919	5.5	2133	542	LOS LOST
532	ATM-10	5420678723	SHL-20	5635577755	0.0	2366	545	SURVIVE
551	SHL-20	5636577755	ATM-10	5420678723	0.0	2366	562	M+F KILL
555	DRG-24	5536477984	T62- 9	5481778539	5.5	779	564	M+F KILL
583	T34-19	5495078020	T62- 6	5484078407	5.5	403	584	SURVIVE
605	SHL-20	5636577755	T62- 6	5495578290	5.5	1508	612	M+F KILL
608	T34-19	5495078020	T62- 6	5484078407	5.5	403	610	PRV KILL
624	ATM-11	5417878713	SHL-20	5635577755	0.0	2388	639	SURVIVE
644	ATM-11	5417878713	SHL-20	5635577755	0.0	2388	659	M+F KILL
649	T34-19	5495078020	T62- 8	5500878501	5.5	484	651	SURVIVE
653	DRG-24	5536477984	T62- 2	5483378467	5.5	682	661	M+F KILL
677	T34-19	5495078020	T62- 8	5513378379	5.8	403	679	SURVIVE
703	T34-19	5495078020	T62- 8	5526178283	5.5	409	705	F KILL

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
367	TOW-19	5495078020	T62- 5	5405679375	5.3	1517	375	SURVIVE
399	TOW-19	5495078020	T62- 5	5415179289	5.3	1494	405	LOS LOST
434	SHL-20	5636577755	T62- 1	5429879191	5.8	2517	445	SURVIVE
459	TOW-19	5495078020	T62- 8	5423579168	4.0	1353	465	F KILL
471	SHL-20	5636577755	T62- 1	5441579076	5.5	2355	482	M+F KILL
476	AT4-10	5418378746	SHL-20	5636577755	0.0	2397	491	SURVIVE
489	TOW-19	5495078020	T62- 8	5423579168	0.0	1353	495	SURVIVE
494	SHL-20	5636577755	T62- 5	5447778927	.5	2223	505	M+F KILL
496	AT4-10	5418378746	SHL-20	5636577755	0.0	2397	510	SURVIVE
506	AT4-11	5411078791	SHL-20	5636577755	0.0	2482	521	M KILL
518	AT4-10	5418378746	SHL-20	5636577755	0.0	2397	532	M+F KILL
519	TOW-19	5495078020	T62- 8	5423579168	0.0	1353	525	M+F KILL
582	DRG-24	5536477984	T62- 9	5494378432	5.5	615	589	M+F KILL
597	TOW-19	5495078020	T62- 6	5493078317	5.5	297	598	SURVIVE
603	T62- 6	5493078317	TOW-19	5495078020	0.0	297	603	M+F KILL
607	AT4-10	5423078700	DRG-24	5535477984	0.0	1341	615	SURVIVE
622	TOW-13	5495078020	T62- 6	5493078317	5.5	297	623	SURVIVE
624	AT4-10	5423078700	DRG-24	5535477984	0.0	1341	632	SURVIVE
631	DRG-24	5536477984	T62- 6	5504678198	5.5	384	635	SURVIVE
640	AT4-10	5423078700	DRG-24	5535477984	0.0	1341	649	SURVIVE
642	TOW-13	5580677808	T62- 4	5451279193	.5	1896	650	SURVIVE
648	DRG-24	5536477984	T62- 6	5505678189	.5	370	653	SURVIVE
674	TOW-18	5580677808	T62- 4	5451279193	.5	1896	683	M+F KILL
674	DRG-24	5536477984	T62- 6	5505678189	.5	370	678	SURVIVE
685	AT4-10	5425478578	DRG-24	5535477984	0.0	1309	693	SURVIVE
701	AT4-10	542[illegible]478578	DRG-24	5535477984	0.0	1309	709	M+F KILL

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
337	SHL-20	5636577755	T62- 9	5391579320	5.8	2907	351	SURVIVE
359	SHL-20	5636577755	T62- 9	5399679217	5.8	2783	373	M+F KILL
381	SHL-20	5636577755	T62- 6	5411879149	5.5	2644	394	M+F KILL
434	SHL-20	5636577755	T62- 1	5429179197	5.5	2526	445	SURVIVE
435	TOW-18	5580677808	T62- 4	5430079458	0.0	2234	446	M+F KILL
463	SHL-20	5636577755	T62- 1	5440979082	5.5	2364	475	SURVIVE
487	AT4-10	5418378746	SHL-20	5636577755	0.0	2397	502	M+F KILL
489	SHL-20	5636577755	T62- 1	5450678988	5.5	2231	500	SURVIVE
568	TOW-19	5495078020	T62- 1	5483978664	5.5	653	571	SURVIVE
642	TOW-19	5495078020	T62- 2	5510278296	5.5	315	643	SURVIVE
650	AT4-10	5430978542	DRG-24	5535477984	0.0	1242	667	SURVIVE
667	TOW-19	5495078020	T62- 2	5510278296	5.5	315	669	M+F KILL
671	AT4-11	5443878797	TOW-19	5495078020	0.0	930	675	M+F KILL
676	AT4-10	5430978542	DRG-24	5535477984	0.0	1242	683	SURVIVE
694	AT4-10	5430978542	DRG-24	5535477984	0.0	1242	701	SURVIVE

Table E-I-1b

FIRING DATA FROM DYNTACS TRIAL 34 EXCURSION

DYN TRIAL 34 E REP 10

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
345	T34-19	5495078020	T62- 5	5395379514	5.3	1790	353	LOS LOST
371	SHL-20	5636577755	T62- 1	5407879403	5.3	2818	385	M+F KILL
372	T34-18	5580677808	T62- 4	5423579515	4.5	2320	382	SURVIVE
377	T34-19	5495078020	T62- 1	5407879403	5.8	1634	385	PRV KILL
406	T34-18	5580677808	T62- 4	5430079458	3.9	2234	417	M+F KILL
409	T34-19	5495078020	T62- 8	5408679387	5.5	1617	416	M+F KILL
456	SHL-20	5636577755	T62- 5	5437879041	5.5	2367	463	SURVIVE
482	SHL-20	5636577755	T62- 5	5445778939	5.5	2237	493	LOS LOST
490	AT4-10	5414478799	SHL-20	5635577755	0.0	2454	505	SURVIVE
511	AT4-10	5414478799	SHL-20	5635577755	0.0	2454	525	SURVIVE
513	SHL-20	5636577755	T62- 5	5447778927	.5	2223	524	SURVIVE
532	SHL-20	56365;7755	T62- 5	5448778916	.5	2208	542	M+F KILL
533	AT4-10	5414478799	SHL-20	5635577755	0.0	2454	547	M KILL
579	T34-19	5495078020	T62- 6	5483578413	5.5	409	581	M+F KILL
582	AT4-10	5416478773	SHL-20	5635577755	0.0	2425	595	M+F KILL
587	DRG-24	5536477984	T62- 9	5495078426	5.5	606	593	SURVIVE
614	DRG-24	5536477984	T62- 9	5507578319	5.5	442	619	LOS LOST
621	T34-19	5495078020	T62- 9	5507578319	5.5	324	623	SURVIVE
639	AT4-10	5418678749	DRG-24	5535477984	0.0	1404	647	SURVIVE
647	T34-19	5495078020	T62- 9	5520178212	5.5	316	643	M+F KILL
654	AT4-10	5418678749	DRG-24	5535477984	0.0	1404	662	SURVIVE
667	AT4-10	5418678749	DRG-24	5535477984	0.0	1404	676	SURVIVE
672	T34-19	5495078020	T62- 2	5485378350	5.3	345	674	M+F KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
347	SHL-20	5632177765	T62- 6	5400579393	6.1	2871	359	M+F KILL
367	TOW-18	5579777800	T62- 6	5403379298	5.0	2366	381	M+F KILL
372	SHL-20	5632177765	T62- 1	5409579313	5.0	2801	386	F KILL
375	TOW-19	5499377965	T62- 9	5394479279	5.0	1735	333	SURVIVL
398	SHL-20	5632077760	ICV-15	5413774362	3.6	2756	414	ICV KILL
400	TOW-18	5579777800	T62- 2	5402579167	0.0	2317	413	LOS LOST
436	TOW-18	5579777800	T62- 5	5448679168	6.1	1954	447	SURVIVL
446	TOW-19	5499377965	T62- 9	5424579354	7.5	1374	453	M+F KILL
469	TOW-19	5499377965	ICV-13	5430579206	0.0	1451	476	LOS LOST
473	TOW-18	5579777800	T62- 5	5464579030	6.1	1745	481	M+F KILL
499	SHL-20	5632177765	ICV-13	5440679145	3.6	2384	511	ICV KILL
517	SHL-20	5632077765	T62- 4	5481278818	0.0	1893	525	LOS LOST
530	TOW-19	5499377965	T62- 4	5487478798	6.1	861	533	M+F KILL
545	TOW-18	5579777800	T62- 2	5475178556	7.5	1317	551	M+F KILL
[illegible]	ATM-1	5412773548	TOW-18	5579777800	0.0	1981	586	M+F KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
359	SHL-20	5632077765	T62- 9	5359773313	5.0	2937	376	M+F KILL
368	TOW-19	5499377965	T62- 6	5406979238	6.1	1599	375	SURVIVE
385	TOW-18	5579777800	T62- 2	5395579212	5.0	2374	399	F KILL
396	SHL-20	5632077765	ICV-13	5410179327	3.6	2758	412	ICV KILL
418	TOW-19	5499377965	T62- 3	5427779027	6.1	1306	424	M+F KILL
426	SHL-20	5632077765	ICV-15	5427879301	3.6	2649	441	ICV KILL
442	TOW-16	5579777800	T62- 4	5447379113	6.1	1925	451	SURVIVE
448	TOW-19	5499377965	T62- 1	5433979097	5.0	1330	454	SURVIVE
476	TOW-19	5499377965	T62- 1	5445079000	5.0	1189	483	SURVIVE
490	TOW-18	5579777800	T62- 4	5457778936	6.1	1626	497	M+F KILL
515	TOW-19	5499377965	T62- 5	5482678872	6.1	932	519	M+F KILL
598	TOW-19	5499377965	T62- 1	5489378603	5.0	660	600	M+F KILL
601	TOW-16	5579777800	T62- 8	5488078553	0.0	1214	607	LOS LOST
609	TOW-19	5499377965	T62- 8	5490278535	0.0	613	611	LOS LOST
614	ATM-11	5408878814	TOW-18	5579777800	0.0	1981	624	M+F KILL
628	SHL-20	5632077765	ATM-11	5408878814	0.0	2457	640	M KILL
623	SHL-20	5632077765	ATM-11	5408878814	0.0	2457	640	M KILL
633	ATM-11	5408878814	SHL-20	5632077765	0.0	2457	644	LOS LOST
651	SHL-20	5632077765	T62- 8	5505878397	5.0	1432	657	SURVIVE
654	DRG-24	5537577989	T62- 6	5507978378	5.0	520	660	SURVIVE
658	ATM-10	5412378849	SHL-20	5632077765	0.0	2457	669	SURVIVE
675	DRG-24	5537577989	T62- 3	5514773319	5.0	435	680	M+F KILL
690	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	697	SURVIVE
702	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	709	SURVIVE
714	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	721	SURVIVE
716	SHL-20	5632077765	ATM-10	5412378849	0.0	2457	728	M KILL
726	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	733	LOS LOST

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
336	TOW-19	5499377965	T62- 6	5394374360	6.1	1777	344	M+F KILL
367	TOW-19	5499377965	T62- 6	5401573717	5.0	1724	373	SURVIVE
372	TOW-16	5579777800	T62- 8	5415974275	5.0	2337	386	M+F KILL
372	SHL-20	5632077765	T62- 8	5405979278	5.0	2773	388	PRV KILL
393	TOW-15	5579777800	T62- 2	5400279174	0.0	2345	407	LOS LOST
397	SHL-20	5632077765	T62- 1	5418479235	5.4	2556	412	SURVIVE
427	SHL-20	5632077765	T62- 1	5429579137	5.0	2519	441	F KILL
435	TOW-15	5579777800	T62- 4	5445179133	6.1	1934	444	M+F KILL
500	TOW-13	5579777800	ICV-13	5440579146	3.6	1963	509	ICV KILL
503	SHL-20	5632077765	ICV-15	5445779165	3.6	2384	515	ICV KILL
524	TOW-16	5579777800	T62- 5	5437078573	6.1	1417	531	M+F KILL
566	TOW-14	5579777800	T62- 9	5439978494	7.5	1168	571	SURVIVE
578	ATM-10	5412378849	TOW-18	5579777800	0.0	1351	585	M+F KILL
582	SHL-20	5632077765	T62- 9	5501278337	7.5	1518	589	M+F KILL
585	ATM-11	5408378814	TOW-18	5579777800	0.0	1951	595	PRV KILL
595	ATM-10	5412378849	SHL-20	5632077765	0.0	2457	606	SURVIVE
598	SHL-20	5632077765	T62- 2	5504478304	7.5	1404	604	SURVIVE
601	DRG-24	5537577989	T62- 2	5506678285	7.5	457	606	SURVIVE
605	ATM-11	5408378814	DRG-24	5537577989	0.0	1523	612	SURVIVE
615	TOW-19	5499377965	T62- 2	5511278246	7.5	327	616	SURVIVE
618	ATM-11	5408378814	DRG-24	5537577989	0.0	1523	625	SURVIVE
619	DRG-24	5537577989	T62- 2	5515775208	7.5	339	623	SURVIVE
624	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	631	SURVIVE
630	ATM-11	5408378814	DRG-24	5537577989	0.0	1523	637	SURVIVE
636	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	643	SURVIVE
643	ATM-11	5408378814	DRG-24	5537577989	0.0	1523	650	SURVIVE
645	TOW-19	5499377965	T62- 2	5521578045	8.6	259	646	M+F KILL
648	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	655	M+F KILL
651	SHL-20	5632077765	ATM-11	5408378814	0.0	2457	663	M KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
350	TOW-19	5499377965	T62- 6	5400679303	6.1	1717	358	SURVIVE
376	SHL-20	5632077765	T62- 1	5411779293	5.0	2773	392	SURVIVE
377	TOW-15	5579777800	T62- 9	5396879263	5.0	2432	391	M+F KILL
407	TOW-15	5579777800	ICV-13	5412679311	3.6	2309	415	ICV KILL
411	SHL-20	5632077765	T62- 1	5425079175	5.0	2598	426	M+F KILL
417	TOW-19	5499377965	T62- 6	5427779027	6.1	1336	423	SURVIVE
433	TOW-18	5579777800	T62- 5	5446379163	6.1	1984	442	SURVIVE
435	SHL-20	5632077765	T62- 3	5428179082	5.0	2480	447	M+F KILL
447	TOW-19	5499377965	T62- 6	5440278900	6.1	1129	452	F KILL
466	TOW-18	5579777800	T62- 5	5462279049	6.1	1775	474	M KILL
503	SHL-20	5632077765	ICV-15	5445779165	3.6	2334	515	ICV KILL
533	TOW-19	5499377965	T62- 4	5463478738	6.1	861	533	M+F KILL
551	TOW-19	5499377965	T62- 2	5477378535	7.5	648	553	M+F KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
368	SHL-20	5632077765	T62- 6	5411079196	0.0	2725	383	LOS LOST
372	TOW-19	5493377965	T62- 6	5418979215	6.1	1570	379	M+F KILL
373	TOW-15	5579777810	T62- 9	5394479275	5.0	2432	387	M+F KILL
390	SHL-20	5632077765	ICV-13	5407679342	3.5	2797	405	ICV KILL
397	TOW-19	5493377965	T62- 8	5412679213	5.0	1558	404	M+F KILL
403	TOW-18	5579777810	ICV-13	5412679311	0.0	2309	416	PRV KILL
417	SHL-20	5632077765	T62- 5	5441979227	6.1	2491	429	M+F KILL
423	TOW-19	5493377965	ICV-15	5418879331	3.5	1606	430	SURVIVE
435	TOW-15	5579777810	T62- 4	5445179133	6.1	1954	444	SURVIVE
454	TOW-19	5493377965	ICV-15	5428979270	3.6	1532	461	ICV KILL
477	SHL-20	5632077765	T62- 1	5447276930	5.0	2275	488	SURVIVE
493	TOW-18	5579777602	T62- 4	5469979316	6.1	1626	500	M+F KILL
544	TOW-19	5493377965	T62- 2	5472778575	7.5	700	547	SURVIVE
550	TOW-15	5579777670	T62- 2	5477378535	7.5	1287	556	M+F KILL
580	TOW-19	5493377965	T62- 1	5489378508	5.0	636	[illegible]	M+F KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
357	TOW-19	5499777965	T62- 1	5401479398	6.1	1755	365	SURVIVE
362	TOW-19	5579777800	T62- 9	5389779313	5.0	2439	376	F KILL
364	SHL-20	5632.77765	T62- 8	5403379298	5.0	2829	393	SURVIVE
383	TOW-18	5579777800	T62- 2	5397679195	5.0	2374	432	F KILL
389	TOW-19	5499777965	T62- 1	5413379274	5.1	1535	396	SURVIVE
394	SHL-20	5632.77765	T62- 6	5414379200	3.1	2685	439	M+F KILL
419	TOW-18	5579777800	ICV-15	5421379316	3.6	2251	432	ICV KILL
420	TOW-19	5499777965	T62- 1	5425079175	5.1	1443	427	M+F KILL
423	SHL-20	5632.77765	T62- 4	5440579172	6.1	2461	435	M+F KILL
499	SHL-20	5632 77765	ICV-13	5440579145	3.6	2384	511	ICV KILL
504	TOW-18	5579777800	ICV-13	5443279130	0.0	1435	513	PRV KILL
513	SHL-20	5632.77765	T62- 5	5471578582	6.1	1305	527	M+F KILL
520	TOW-19	5499377965	T62- 6	5469573603	6.1	725	523	PRV KILL
586	ATM-11	5403878814	TOW-18	5579777800	0.0	1981	596	SURVIVE
653	SHL-20	5632077765	T62- 5	5543578340	6.1	1031	657	M+F KILL
653	ATM-11	5403878814	TOW-18	5579777800	0.0	1981	658	SURVIVE
667	TOW-18	5579777800	ATM-11	5408878814	0.0	1981	676	M KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
354	TOW-19	5499377955	T62- 5	5402779281	6.1	1688	362	M+F KILL
355	SHL-20	5632077765	T62- 6	5406379238	0.0	2812	371	PRV KILL
359	TOW-18	5579777800	T62- 3	5386179273	5.0	2517	374	SURVIVE
369	TOW-19	5499377965	T62- 1	5407379332	5.0	1700	377	SURVIVE
379	SHL-20	5632077765	T62- 3	5399179246	0.0	2851	395	LOS LOST
400	TOW-18	5579777800	T62- 2	5402579163	0.0	2317	413	LOS LOST
401	TOW-19	5499377965	T62- 1	5418479233	5.0	1529	438	M+F KILL
409	SHL-20	5632077765	T62- 5	5437479267	6.1	2521	423	SURVIVE
422	TOW-18	5579777800	ICV-15	5421379314	3.6	2251	435	ICV KILL
451	SHL-20	5632077765	T62- 5	5455479169	6.1	2232	452	M+F KILL
453	TOW-19	5499377965	T62- 3	5434879024	5.0	1273	464	SURVIVE
475	TOW-19	5499377965	T62- 2	5435778844	7.5	1145	483	SURVIVE
500	TOW-18	5579777800	ICV-13	5440679145	3.6	1963	509	ICV KILL
513	TOW-19	5499377965	T62- 4	5476778857	6.1	957	517	SURVIVE
521	TOW-18	5579777800	T62- 4	5481278818	6.1	1445	528	SURVIVE
541	TOW-19	5499377965	T62- 4	5490278733	0.0	816	544	LOS LOST
556	TOW-18	5579777800	T62- 9	5485478532	7.5	1257	562	SURVIVE
554	TOW-19	5499377965	T62- 2	5461878497	7.5	597	561	SURVIVE
561	SHL-20	5632077765	T62- 9	5499784314	7.5	1662	569	M+F KILL
573	SHL-20	5632077765	T62- 2	5490878420	7.5	1575	580	M+F KILL
582	ATM-10	5412378340	TOW-18	5579777800	0.0	1931	592	M+F KILL
583	ATM-11	5408878814	TOW-18	5579777800	0.0	1931	593	PRV KILL
592	ATM-10	5412378349	SHL-20	5632077765	0.0	2457	610	SURVIVE
637	TOW-19	5499377965	T62- 8	5499078456	5.0	508	639	M+F KILL
663	DRG-24	5537577989	T62- 4	5544478266	6.1	329	667	M+F KILL
672	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	679	SURVIVE
684	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	691	SURVIVE
685	SHL-20	5632077765	ATM-11	5408878814	0.0	2457	697	SURVIVE
689	ATM-10	5412378349	SHL-20	5632077765	0.0	2457	700	M KILL
698	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	705	M+F KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE (cont)

IUA TRIAL 34 REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
705	ATM-10	5412373649	SHL-20	5632077765	0.0	2457	715	M+F KILL
714	ATM-11	5413373314	SHL-20	5632077765	0.0	2457	725	P+V KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
347	SHL-20	5632077765	T62- 6	5402779231	6.1	2341	363	SURVIVE
361	TOW-19	5499377965	T62- 8	5399779339	5.1	1729	369	F KILL
375	SHL-20	5632077765	T62- 9	5396579263	0.0	2330	391	LOS LOST
377	TOW-18	5579777800	T62- 1	5411774293	5.0	2318	390	SURVIVE
387	TOW-19	5499377965	T62- 2	5395579212	5.0	1679	395	SURVIVE
409	SHL-20	5632077765	ICV-13	5410179327	3.6	2733	415	ICV KILL
413	TOW-18	5579777800	ICV-15	5415279346	3.6	2333	416	SURVIVE
419	TOW-19	5499377965	T62- 2	5407279131	5.0	1515	426	M+F KILL
448	TOW-18	5579777800	T62- 4	5443967939	5.1	1345	457	M KILL
477	TOW-19	5499377965	T62- 1	5445079000	5.0	1139	482	SURVIVE
501	SHL-20	5632077765	ICV-15	5445779165	3.6	2384	513	ICV KILL
500	TOW-18	5579777800	T62- 5	5478078912	6.1	1536	513	SURVIVE
511	TOW-19	5499377965	T62- 5	5480378891	6.1	937	515	M+F KILL
521	SHL-20	5632077765	T62- 6	5471578582	6.1	1836	529	M+F KILL
559	SHL-20	5632077765	T62- 9	5487678513	7.5	1631	567	SURVIVE
562	DRG-24	5537577939	T62- 9	5439978494	7.5	753	569	M+F KILL
580	ATM-10	5412778843	TOW-18	5579777800	0.0	1931	590	SURVIVE
582	ATM-11	5408873814	DRG-24	5537577939	0.0	1523	589	SURVIVE
594	ATM-11	5408873814	DRG-24	5537577939	0.0	1523	601	SURVIVE
[illegible]	TOW-19	5499377965	T62- 1	5432375603	5.0	635	601	F KILL
[illegible]	ATM-11	5408873814	DRG-24	5537577939	0.0	1523	613	SURVIVE
[illegible]	ATM-11	5408873814	DRG-24	5537577939	0.0	1523	625	M+F KILL

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
341	SHL-21	5632777765	T62- 6	5406673303	5.1	2871	357	M+F KILL
364	TOW-19	5433377965	T62- 3	5339779313	5.1	1730	372	SURVIVE
370	SHL-21	5632177765	T62- 1	5403579313	5.0	2801	385	F KILL
374	TOW-15	5573777300	T62- 8	5405973278	5.0	2337	388	M+F KILL
399	TOW-19	5493377965	T62- 9	5401479230	5.0	1624	406	M+F KILL
406	TOW-15	5573777300	T62- 2	5404379146	0.0	2239	419	LOS LOST
427	TOW-19	5493377965	ICV-15	5421379316	3.6	1579	434	SURVIVE
430	SHL-21	5632177765	T62- 4	5442379153	5.1	2401	442	M+F KILL
436	TOW-13	5573777300	T62- 5	5443679169	6.1	1954	445	M+F KILL
440	TOW-19	5493377965	T62- 2	5416479059	7.5	1432	447	M+F KILL
488	SHL-21	5632177765	ICV-15	5441679195	3.6	2414	500	ICV KILL
522	SHL-21	5632177765	ICV-13	5448279100	3.5	2237	533	ICV KILL
529	TOW-15	5579777500	ICV-13	5450379085	0.0	1849	538	PRV KILL
573	AT4-11	5419879814	TOW-13	5579777300	0.0	1981	589	M KILL
562	AT4-11	5412778849	TOW-13	5579777500	0.0	1981	592	LOS LOST

Table E-I-2a

FIRING DATA FROM IUA TRIAL 34 BASE CASE

IUA TRIAL 34 REP 10

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
341	SHL-20	5632077765	T62- 6	5400679363	6.1	2871	357	M+F KILL
352	TOW-19	5499377965	T62- 6	5400679363	3.0	1588	356	PRV KILL
366	SHL-20	5632077765	T62- 1	5407379332	5.0	2631	382	SURVIVE
369	TOW-18	5579777800	T62- 8	5405979276	5.0	2356	383	M+F KILL
380	TOW-19	5499377965	T62- 3	5394479279	5.0	1706	388	SURVIVE
402	TOW-18	5579777800	T62- 2	5402579153	0.0	2239	415	LOS LOST
402	SHL-20	5632077765	T62- 1	5420679215	5.0	2626	417	M+F KILL
415	TOW-19	5499377965	T62- 9	5408479131	5.0	1542	422	M+F KILL
437	TOW-18	5579777800	T62- 5	5446379188	6.1	1354	442	M+F KILL
495	SHL-20	5632077765	ICV-15	5444179180	3.5	2414	505	ICV KILL
502	TOW-18	5579777800	ICV-13	5448579145	3.5	1363	511	SURVIVE
514	SHL-20	5632077765	T62- 4	5479378537	0.0	1893	523	LOS LOST
535	TOW-18	5579777800	ICV-13	5452879364	3.0	1343	544	ICV KILL
537	SHL-20	5632077765	ICV-13	5454979143	0.0	2237	543	PRV KILL
539	TOW-19	5499377965	T62- 4	5488078755	6.1	816	542	M KILL
557	TOW-18	5579777800	T62- 2	5479578517	7.5	1257	559	M+F KILL
559	TOW-19	5499377965	T62- 2	5479578517	0.0	597	560	PRV KILL

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
377	TOW-18	5579777800	T62- 9	5395879263	5.0	2402	391	SURVIVE
388	TOW-19	5499377965	T62- 1	5413979274	5.0	1615	395	SURVIVE
400	SHL-20	5632077765	T62- 1	5420679215	5.0	2656	415	SURVIVE
428	TOW-18	5579777800	ICV-15	5423879391	3.6	2222	441	ICV KILL
438	TOW-19	5499377965	T62- 1	5431779117	5.0	1358	445	M+F KILL
466	TOW-18	5579777800	T62- 5	5462279049	6.1	1775	475	M+F KILL
481	TOW-19	5499377965	T62- 9	5442578899	0.0	1116	485	LOS LOST
520	SHL-20	5632077765	ICV-13	5448279100	3.6	2297	531	ICV KILL
539	TOW-19	5499377965	T62- 6	5477878518	6.1	612	541	SURVIVE
555	TOW-18	5579777800	T62- 6	5484178455	6.1	1193	560	M+F KILL
597	TOW-18	5579777800	T62- 9	5508078339	7.5	931	601	M+F KILL
614	DRG-24	5537577989	T62- 2	5513478227	7.5	368	613	M+F KILL
623	ATM-11	5408878814	TOW-18	5579777800	0.0	1981	633	M+F KILL
644	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	651	M+F KILL
672	TOW-19	5499377965	T62- 8	5512478339	5.0	418	674	M+F KILL
674	SHL-20	5632077765	T62- 4	5543978225	6.1	943	678	M+F KILL
703	ATM-11	5408878814	SHL-20	5632077765	0.0	2457	714	SURVIVE

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
371	TOW-19	5499377965	T62- 6	5403979218	6.1	1570	378	M+F KILL
380	TOW-18	5579777800	T62- 1	5411779293	5.0	2308	393	SURVIVE
401	SHL-20	5632077765	T62- 8	5417179180	5.0	2626	416	SURVIVE
416	TOW-19	5499377965	ICV-15	5416279346	3.6	1606	423	ICV KILL
425	TOW-18	5579777800	ICV-13	5417779281	3.6	2222	438	ICV KILL
452	TOW-19	5499377965	T62- 9	5423779035	7.5	1346	458	M+F KILL
461	SHL-20	5632077765	T62- 8	5439278964	5.0	2333	473	SURVIVE
477	TOW-18	5579777800	T62- 5	5465779011	6.1	1715	485	SURVIVE
521	TOW-18	5579777800	T62- 5	5484878853	6.1	1446	528	M+F KILL
566	TOW-19	5499377965	T62- 2	5484078478	7.5	547	568	M+F KILL
664	TOW-18	5579777800	T62- 1	5513878392	5.0	918	668	SURVIVE
689	AT4-11	5408878814	TOW-18	5579777800	0.0	1981	699	SURVIVE
734	SHL-20	5632077765	T62- 8	5532378059	0.0	1035	738	LOS LOST

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
385	TOW-19	5499377965	T62- 6	5415379154	6.1	1511	392	M+F KILL
392	TOW-18	5579777800	T62- 1	5416279254	0.0	2249	405	LOS LOST
403	SHL-20	5632077765	T62- 8	5417179180	5.0	2626	418	M+F KILL
431	TOW-19	5499377965	T62- 9	5415579131	6.9	1460	438	M+F KILL
442	TOW-18	5579777800	T62- 5	5450979148	6.1	1925	451	SURVIVE
463	SHL-20	5632077765	T62- 1	5442879019	5.0	2333	475	M+F KILL
467	TOW-19	5499377965	ICV-13	5430579206	0.0	1451	474	LOS LOST
495	TOW-18	5579777800	T62- 5	5473578951	6.1	1596	502	SURVIVE
521	SHL-20	5632077765	ICV-13	5448279100	3.6	2297	532	SURVIVE
534	TOW-18	5579777800	ICV-15	5456479099	5.0	1849	543	ICV KILL
543	TOW-19	5499377965	T62- 4	5490278738	0.0	816	546	LOS LOST
573	TOW-19	5499377965	T62- 2	5488678439	7.5	499	575	SURVIVE
605	SHL-20	5632077765	ICV-13	5477178808	0.0	1921	614	LOS LOST
615	TOW-19	5499377965	T62- 2	5511278246	7.5	327	616	M+F KILL
635	ATM-11	5408878314	SHL-20	5632077765	0.0	2457	646	SURVIVE
646	TOW-18	5579777800	ICV-13	5489178680	0.0	1293	652	LOS LOST
676	ATM-11	5408878314	SHL-20	5632077765	0.0	2457	687	M+F KILL
689	DRG-24	5537577989	T62- 5	5559378202	8.1	280	692	SURVIVE
694	TOW-18	5579777800	T62- 4	5557178142	8.6	415	695	M+F KILL
702	ATM-10	5412378849	TOW-18	5579777800	0.0	1981	712	SURVIVE
748	ATM-11	5410978792	TOW-18	5579777800	0.0	1981	758	SURVIVE

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
385	TOW-19	5499377965	T62- 8	5408279258	5.0	1615	392	SURVIVE
386	TOW-18	5579777800	T62- 1	5413979274	0.0	2279	399	LOS LOST
396	SHL-20	5632077765	T62- 1	5418479235	5.0	2656	411	M+F KILL
426	TOW-18	5579777800	ICV-15	5421379316	3.6	2222	439	ICV KILL
450	TOW-19	5499377965	T62- 8	5432579043	5.0	1301	456	SURVIVE
454	SHL-20	5632077765	ICV-13	5427979221	3.6	2562	468	ICV KILL
469	TOW-18	5579777800	T62- 4	5458679014	6.1	1745	477	M+F KILL
482	TOW-19	5499377965	T62- 2	5438978864	0.0	1116	486	LOS LOST
533	TOW-19	5499377965	T62- 6	5473678561	6.1	640	535	SURVIVE
540	TOW-18	5579777800	T62- 6	5479978498	6.1	1281	546	M+F KILL
578	TOW-18	5579777800	T62- 9	5496778435	7.5	1079	582	M+F KILL
596	ATM-11	5408878814	TOW-18	5579777800	0.0	1981	606	SURVIVE
614	DRG-24	5537577989	T62- 2	5513478227	7.5	368	618	SURVIVE
644	ATM-11	5408878814	TOW-18	5579777800	0.0	1981	654	M+F KILL
650	TOW-19	5499377965	T62- 2	5521077993	8.6	248	651	F KILL
680	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	687	SURVIVE
687	TOW-19	5499377965	T62- 8	5516878299	5.0	401	688	M+F KILL
714	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	721	SURVIVE
721	SHL-20	5632077765	ATM-11	5408878814	0.0	2457	733	M+F KILL

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
379	TOW-13	5579777800	T62- 1	5411779293	5.0	2308	392	M+F KILL
382	TOW-19	5499377965	T62- 6	5413179175	6.1	1511	389	M+F KILL
404	SHL-20	5632077765	T62- 8	5413279161	5.0	2626	419	SURVIVE
425	TOW-19	5499377965	ICV-13	5417779281	3.6	1579	432	SURVIVE
428	TOW-18	5579777800	ICV-15	5423879301	3.6	2222	441	ICV KILL
459	TOW-19	5499377965	T62- 2	5427778961	7.5	1289	465	M+F KILL
472	SHL-20	5632077765	T62- 8	5441478965	5.0	2305	484	M+F KILL
475	TOW-13	5579777800	T62- 5	5464579030	6.1	1715	483	SURVIVE
529	TOW-18	5579777800	T62- 5	5489378813	0.0	1387	536	LOS LOST
539	SHL-20	5632077765	ICV-13	5454979043	5.0	2237	550	ICV KILL
569	TOW-19	5499377965	T62- 9	5489978494	7.5	523	571	M+F KILL
651	TOW-18	5579777800	T62- 5	5541178359	6.1	676	653	M+F KILL
651	TOW-19	5499377965	T62- 5	5541178359	0.0	550	653	PPV KILL
667	SHL-20	5632077765	T62- 4	5545778246	6.1	1002	671	M+F KILL
681	ATM-10	5412378849	TOW-13	5573777800	0.0	1981	691	M+F KILL
703	ATM-11	5408878814	SHL-20	5632077765	0.0	2457	714	SURVIVE
746	SHL-20	5632077765	ATM-11	5410978792	4.2	2457	753	M KILL
775	ATM-10	5417978785	SHL-20	5632077765	0.0	2380	786	M+F KILL

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
392	TOW-18	5579777800	T62- 1	5416279254	0.0	2249	405	LOS LOST
394	TOW-19	5499377965	T62- 8	5412679219	5.0	1586	401	SURVIVE
403	SHL-20	5632077765	T62- 8	5417179180	5.0	2626	418	SURVIVE
443	TOW-18	5579777800	T62- 4	5447379113	6.1	1925	452	F KILL
466	TOW-19	5499377965	T62- 8	5437079004	5.0	1245	472	SURVIVE
470	SHL-20	5632077765	T62- 8	5441478965	5.0	2305	482	SURVIVE
483	TOW-18	5579777800	T62- 5	5465978990	6.1	1685	491	M+F KILL
532	TOW-19	5499377965	T62- 6	5473678561	6.1	640	534	M+F KILL
535	SHL-20	5632077765	ICV-15	5456479099	5.0	2267	545	ICV KILL
577	TOW-18	5579777800	T62- 2	5493178401	7.5	1079	581	M+F KILL
606	ATM-11	5408878814	TOW-18	5579777800	0.0	1981	615	SURVIVE
616	TOW-18	5579777800	T62- 9	5517078262	7.5	812	619	M+F KILL
631	TOW-19	5499377965	ICV-13	5483178744	5.0	835	634	ICV KILL
666	TOW-19	5499377965	T62- 1	5513878392	5.0	429	668	M KILL
681	SHL-20	5632077765	T62- 8	5516878299	5.0	1289	686	M+F KILL

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
369	SHL-20	5632077765	T62- 6	5411079196	0.0	2725	384	LOS LOST
379	TOW-18	5579777800	T62- 9	5396879263	5.0	2402	393	SURVIVE
380	TOW-19	5499377965	T62- 6	5413179175	6.1	1541	387	M+F KILL
421	TOW-19	5499377965	T62- 8	5421579141	5.0	1443	429	M+F KILL
425	TOW-18	5579777800	ICV-13	5417779281	3.6	2222	438	ICV KILL
432	SHL-20	5632077765	T62- 1	5431779117	5.0	2480	444	M+F KILL
470	TOW-19	5499377965	T62- 9	5435778957	7.5	1202	475	M KILL
473	TOW-18	5579777800	T62- 5	5464579030	6.1	1745	481	M+F KILL
491	SHL-20	5632077765	T62- 4	5463978916	6.1	2043	501	M+F KILL
565	TOW-19	5499377965	T62- 2	5484078478	7.5	547	567	SURVIVE
580	TOW-18	5579777800	T62- 2	5493178401	7.5	1079	584	M+F KILL
580	DRG-24	5537577989	T62- 2	5495478382	0.0	635	587	PRV KILL
605	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	612	SURVIVE
625	TOW-18	5579777800	ATM-10	5412378849	0.0	1981	638	M KILL
638	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	645	LOS LOST
647	TOW-19	5499377965	ICV-15	5492778715	0.0	761	650	LOS LOST
657	ATM-11	5408878814	TOW-18	5579777800	0.0	1981	667	SURVIVE
699	SHL-20	5632077765	ATM-11	5408878814	0.0	2457	711	M+F KILL
701	TOW-19	5499377965	ICV-15	5508878545	5.0	567	703	ICV KILL

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
381	TOW-19	5499377965	T62- 6	5413179175	6.1	1511	388	SURVIVE
392	TOW-18	5579777800	T62- 8	5412679219	0.0	2249	403	LOS LOST
406	SHL-20	5632077765	T62- 1	5422879196	5.0	2626	421	M KILL
430	TOW-19	5499377965	T62- 6	5434078964	6.1	1246	436	M+F KILL
437	TOW-18	5579777800	T62- 5	5448679168	6.1	1954	446	M KILL
466	TOW-19	5499377965	T62- 9	5433578977	7.5	1230	472	F KILL
478	TOW-18	5579777800	T62- 4	5453178976	6.1	1715	485	SURVIVE
479	SHL-20	5632077765	T62- 8	5443678945	5.0	2246	490	M+F KILL
517	TOW-18	5579777800	ICV-15	5449279150	3.6	1906	526	ICV KILL
536	SHL-20	5632077765	ICV-13	5452879064	5.0	2237	547	SURVIVE
570	TOW-19	5499377965	T62- 2	5486378459	7.5	523	572	M+F KILL
601	ATM-10	5412378849	SHL-20	5632077765	0.0	2457	612	SURVIVE
609	SHL-20	5632077765	ICV-13	5477178808	0.0	1892	618	LOS LOST
639	TOW-18	5579777800	ICV-13	5487078702	5.0	1322	645	SURVIVE
651	TOW-19	5499377965	T62- 4	5537678324	6.1	550	653	SURVIVE
667	DRG-24	5537577989	T62- 4	5545778246	6.1	307	670	M+F KILL
668	ATM-11	5408878814	TOW-18	5579777800	0.0	1981	678	M+F KILL
704	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	711	SURVIVE
717	SHL-20	5632077765	ATM-11	5408878814	0.0	2457	729	M KILL
744	ATM-10	5413478838	SHL-20	5632077765	0.0	2457	755	SURVIVE
770	TOW-19	5499377965	ICV-13	5529478255	5.0	443	772	SURVIVE

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
383	TOW-18	5579777800	T62- 1	5413979274	0.0	2279	396	LOS LOST
398	SHL-20	5632077765	T62- 8	5417179180	5.0	2656	413	SURVIVE
409	TOW-19	5499377965	T62- 9	5405179198	5.0	1569	416	M+F KILL
435	TOW-18	5579777800	ICV-13	5422879251	3.6	2194	448	SURVIVE
454	TOW-19	5499377965	T62- 1	5435179078	5.0	1301	460	SURVIVE
469	SHL-20	5632077765	T62- 8	5441478965	5.0	2305	481	M+F KILL
474	TOW-18	5579777800	T62- 4	5461078995	6.1	1715	482	SURVIVE
520	TOW-18	5579777800	T62- 4	5483478798	6.1	1417	533	SURVIVE
531	SHL-20	5632077765	ICV-15	5455479099	5.0	2267	542	ICV KILL
541	TOW-19	5499377965	T62- 5	5493878773	0.0	816	544	LOS LOST
576	TOW-18	5579777800	T62- 2	5490878420	7.5	1108	580	SURVIVE
584	TOW-19	5499377965	T62- 6	5494578349	6.1	373	585	M+F KILL
597	ATM-11	5408878314	TOW-18	5579777800	0.0	1981	607	SURVIVE
643	TOW-19	5499377965	T62- 4	5537678324	6.1	548	650	SURVIVE
665	SHL-20	5632077765	T62- 5	5550278280	6.1	1002	669	SURVIVE
683	TOW-18	5579777800	T62- 1	5520478334	5.0	800	685	M+F KILL
687	TOW-19	5499377965	T62- 4	5555878167	8.1	608	689	M+F KILL
691	ATM-10	5412378849	TOW-18	5579777800	0.0	1981	701	SURVIVE
759	ATM-10	5416278807	SHL-20	5632077765	0.0	2429	770	SURVIVE
760	SHL-20	5632077765	ATM-10	5416278807	2.2	2429	772	SURVIVE
777	TOW-18	5579777800	ICV-13	5531478233	5.0	648	779	ICV KILL

Table E-I-2-b

FIRING DATA FROM IUA TRIAL 34 EXCURSION

IUA TRIAL 34 E REP 10

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
373	SHL-20	5632077765	T62- 6	5413179175	0.0	2696	388	LOS LOST
380	TOW-19	5499377965	T62- 8	5405979278	5.0	1643	388	F KILL
419	TOW-18	5579777800	ICV-13	5417779281	3.6	2251	432	ICV KILL
420	TOW-19	5499377965	T62- 9	5410779164	5.0	1515	427	SURVIVE
459	TOW-19	5499377965	T62- 2	5427778961	7.5	1289	465	M+F KILL
469	TOW-18	5579777800	T62- 5	5462279049	6.1	1745	477	M+F KILL
484	SHL-20	5632077765	T62- 4	5467778936	6.1	2073	494	M+F KILL
507	TOW-18	5579777800	ICV-15	5445779165	3.6	1935	516	ICV KILL
550	TOW-19	5499377965	T62- 6	5482078476	6.1	557	552	SURVIVE
578	DRG-24	5537577989	T62- 6	5494578349	6.1	593	585	SURVIVE
583	TOW-18	5579777800	T62- 9	5498978417	7.5	1049	587	M+F KILL
597	TOW-19	5499377965	T62- 6	5500878285	6.1	302	598	M+F KILL
602	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	609	SURVIVE
610	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	617	SURVIVE
633	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	640	SURVIVE
642	TOW-18	5579777800	ATM-11	5408878814	0.0	1981	651	SURVIVE
644	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	651	SURVIVE
671	ATM-10	5412378849	DRG-24	5537577989	0.0	1523	678	SURVIVE
677	ATM-11	5408878814	DRG-24	5537577989	0.0	1523	684	SURVIVE
683	SHL-20	5632077765	ATM-10	5412378849	0.0	2457	695	M KILL
685	DRG-24	5537577989	T62- 1	5522678314	5.0	378	689	SURVIVE
695	TOW-18	5579777800	ATM-11	5408878814	0.0	1981	704	M KILL

Table E-I-3

FIRING DATA FROM TETAM PHASE III FIELD TRIAL 34

CDEC TRIAL 34

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
340	TOW-19	5498777965	T62- 1	5397273414	5.1	1531	343	SURVIVE
375	TOW-19	5498777966	T62- 1	5411873257	7.3	1451	385	M+F KILL
380	SHL-20	5632277771	T62- 5	5412179296	6.9	2641	402	SURVIVE
413	TOW-18	5580177813	T62- 4	5401179282	4.7	2113	423	SURVIVE
418	TOW-19	5498777966	T62- 6	5415373138	5.6	1472	425	M+F KILL
438	SHL-20	5632277771	T62- 5	5430379082	6.1	2483	459	SURVIVE
475	TOW-18	5580177813	0	0 0	0.0	0	0	UNPAIRED
489	TOW-19	5498777966	T62- 9	5449575719	7.3	870	493	SURVIVE
513	TOW-18	5580177813	T62- 4	5457373130	3.[illegible]	1854	521	SURVIVE
529	DRG-24	5537477988	T62- 9	5475378550	6.5	352	541	LOS LOST
548	TOW-19	5498777966	T62- 9	5477873540	5.9	573	551	M+F KILL
550	TOW-18	5580177803	T62- 4	5469579018	4.7	1512	557	M+F KILL
576	ATM-10	5419873837	0	0 0	0.0	0	0	UNPAIRED
583	TOW-19	5498777965	T62- 5	5475178599	4.7	516	586	M+F KILL
596	DRG-24	5537477988	T62- 2	5482978398	7.6	555	614	SURVIVE
599	TOW-18	5580177877	IDV-17	5458179076	3.5	1732	607	SURVIVE
625	ATM-11	5417878914	0	0 0	0.0	0	0	UNPAIRED
627	SHL-20	5632277771	T62- 2	5437473300	7.0	1464	634	SURVIVE
645	TOW-19	5498777966	T62- 6	6000050000	0.0	253	652	LOS LOST
654	DRG-24	5537477988	T62- 2	5549673219	6.5	333	659	SURVIVE
666	ATM-10	5411573334	DRG-24	5537477988	0.0	1525	675	SURVIVE
683	ATM-11	5417873913	0	0 0	0.0	0	0	UNPAIRED
688	T62- 2	5516778195	0	0 0	0.0	0	0	UNPAIRED
707	DRG-24	5537477988	T62- 2	5522273178	4.3	279	711	SURVIVE
710	TOW-19	5498777965	0	0 0	0.0	0	0	UNPAIRED
754	ATM-10	5418178754	SHL-20	5632277771	0.0	2333	758	F KILL
762	SHL-20	5632277771	T62- 2	5548278074	3.8	913	757	SURVIVE
802	ATM-10	5419378726	SHL-20	5632277771	0.0	2334	816	M+F KILL
838	ATM-10	5419378726	SHL-20	5632277771	0.0	2338	852	PRV KILL
895	ATM-10	5419378728	DRG-24	5537477988	0.0	1331	905	SURVIVE

Table E-I-3

FIRING DATA FROM TETAM PHASE III FIELD TRIAL 34

CFC TRIAL 34

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
956	ATM-11	5429378763	DRG-4	5537477986	0.0	1329	[illegible]	SURVIVE
1003	ATM-11	5429378761	DRG-4	5537477988	0.0	1333	[illegible]	SURVIVE

ANNEX E-II

TRIAL 96 FIRING DATA

1. This annex contains firing data for Trial 96.

2. The following tables are provided.

Number	Title
E-II-1a	Firing Data from DYNTACS Trial 96 Base Case
E-II-1b	Firing Data from DYNTACS Trial 96 Excursion
E-II-2a	Firing Data from IUA Trial 96 Base Case
E-II-2b	Firing Data from IUA Trial 96 Excursion
E-II-3	Firing Data from TETAM Phase III Field Trial 96

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
312	SHL-21	5567177856	ATM-10	5375180147	0.0	2988	327	SURVIVE
373	TOW-13	5554577723	T62- 2	5396079133	5.5	2151	387	M+F KILL
411	TOW-13	5554577723	T62- 1	5406479137	5.6	2044	421	SURVIVE
416	SHL-21	5567177856	ATM-11	5408779018	6.5	1363	427	LOS LOST
426	T62- 1	5416173[illegible]	TOW-19	5554577723	0.0	1377	429	SURVIVE
441	SHL-21	5567177856	ATM-11	5417478943	4.3	1832	449	M+F KILL
443	TOW-13	5554577723	T62- 1	541817302[illegible]	0.0	1377	453	M+F KILL
459	T62- 8	5421273015	TOW-19	5554577723	0.0	1352	461	SURVIVE
461	SHL-21	5567177856	ICV-15	5425378907	5.5	1765	469	LOS LOST
473	T62- 8	5421273015	TOW-19	5554577728	0.0	1352	474	SURVIVE
477	TOW-13	5554577723	T62- 8	5421273015	0.0	1352	486	SURVIVE
486	SHL-21	5567177856	ICV-15	5425378907	5.7	1765	495	ICV KILL
486	T62- 8	5421273015	TOW-19	5554577723	0.0	1352	493	M+F KILL
511	T62- 9	5439478435	SHL-21	5567177856	0.0	1423	512	SURVIVE
524	T62- 9	5439478435	SHL-21	5567177856	0.0	1423	525	SURVIVE
534	SHL-21	5567177856	T62- 8	5439578776	5.6	1573	542	M+F KILL
535	T62- 9	5439478435	SHL-21	5567177856	0.0	1423	536	SURVIVE
551	T62- 9	5439478436	SHL-21	5567177856	0.0	1423	552	SURVIVE
551	SHL-21	5567177856	T62- 9	5439478436	5.0	1423	558	M+F KILL
618	T62- 7	5476578654	DRG-23	5500478093	0.0	610	618	SURVIVE
626	T62- 7	5476578654	DRG-23	5500478093	0.0	610	628	M+F KILL
701	DRG-24	5495078020	T62- 7	5516178451	5.0	480	706	LOS LOST
712	T62- 7	5516178451	DRG-24	5495078020	0.0	480	719	SURVIVE
721	ATM-10	5509678499	DRG-24	5495078020	0.0	502	724	M+F KILL
724	DRG-24	5495078020	T62- 7	5516178451	5.0	480	729	SURVIVE
757	T62- 7	5527578354	SHL-21	5567177856	0.0	636	757	SURVIVE
759	ATM-10	5524678379	SHL-21	5567177856	0.0	674	763	M+F KILL
772	SHL-21	5567177856	T62- 7	5527578354	5.0	536	773	SURVIVE
797	TOW-13	5586877803	T62- 3	5554778280	4.2	576	799	M+F KILL
823	TOW-15	5586877803	ICV-14	5550378315	3.0	533	826	ICV KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 2

FIRE	FIRING WEAPON		TARGET WEAPON			RANGE	IMPACT	
TIME	PLAYER	LOCATION	PLAYER	LOCATION	VEL	(METERS)	TIME	RESULT
253	SHL-21	5567177856	ATM-10	5375180147	0.0	2988	268	M+F KILL
377	TOW-19	5554577728	ATM-11	5395079123	6.7	2119	387	SURVIVE
415	TOW-19	5554577728	ATM-11	5395079123	6.7	2119	424	M KILL
458	T62- 2	5423179030	TOW-19	5554577728	0.0	1849	460	SURVIVE
459	T62- 8	5421579004	TOW-19	5554577728	0.0	1843	461	SURVIVE
463	TOW-19	5554577728	T62- 1	5431578904	0.0	1701	471	F KILL
471	T62- 8	5421579004	TOW-19	5554577728	0.0	1843	473	SURVIVE
478	T62- 2	5423179030	TOW-19	5554577728	0.0	1849	480	SURVIVE
479	T62- 1	5431578904	TOW-19	5554577728	0.0	1701	480	SURVIVE
479	SHL-21	5567177856	ICV-15	5421578909	2.2	1737	487	ICV KILL
484	T62- 8	5421579004	TOW-19	5554577728	0.0	1843	485	SURVIVE
495	TOW-19	5554577728	T62- 1	5431578904	0.0	1701	503	SURVIVE
498	T62- 8	5421579004	TOW-19	5554577728	0.0	1843	499	M+F KILL
502	T62- 2	5423179030	TOW-19	5554577728	0.0	1849	504	PRV KILL
567	SHL-21	5567177856	T62- 2	5444478811	5.6	1554	575	LOS LOST
567	T62- 8	5442278790	SHL-21	5567177856	0.0	1560	568	SURVIVE
576	T62- 2	5444478811	SHL-21	5567177856	0.0	1554	577	SURVIVE
583	SHL-21	5567177856	T62- 2	5444478811	0.0	1554	590	M+F KILL
584	T62- 8	5442278790	SHL-21	5567177856	0.0	1560	585	SURVIVE
605	T62- 8	5442278790	SHL-21	5567177856	0.0	1560	606	SURVIVE
614	DRG-24	5495078020	T62- 7	5476978651	5.6	656	621	SURVIVE
617	T62- 7	5476978651	SHL-21	5567177856	0.0	1202	618	SURVIVE
618	T62- 8	5442278790	SHL-21	5567177856	0.0	1560	619	SURVIVE
634	DRG-24	5495078020	T62- 7	5476978651	0.0	656	641	SURVIVE
637	T62- 7	5476978651	SHL-21	5567177856	0.0	1202	638	M+F KILL
639	DRG-23	5500478093	T62- 7	5476978651	0.0	605	646	SURVIVE
663	DRG-23	5500478093	T62- 7	5491678571	5.6	487	668	LOS LOST
714	DRG-23	5500478093	T62- 8	5481178521	5.5	470	719	M+F KILL
733	DRG-24	5495078020	T62- 3	5496678537	6.0	518	739	SURVIVE
742	T62- 3	5496678537	DRG-24	5495078020	0.0	518	743	M+F KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 2

FIRE	FIRING WEAPON		TARGET WEAPON			RANGE	IMPACT	
TIME	PLAYER	LOCATION	PLAYER	LOCATION	VEL	(METERS)	TIME	RESULT
752	T62- 3	5496578537	DRG-23	5500478093	0.0	446	753	M+F KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
309	SHL-21	5567177856	ATM-10	5375180147	0.0	2988	323	SURVIVE
373	TOW-19	5554577728	T62- 8	5397079145	5.8	2118	383	M+F KILL
410	TOW-19	5554577728	T62- 2	5398279173	5.6	2129	420	SURVIVE
425	T62- 1	5420379006	TOW-19	5554577728	0.0	1853	426	SURVIVE
439	T62- 1	5420379006	TOW-19	5554577728	0.0	1853	440	SURVIVE
448	TOW-19	5554577728	T62- 2	5423278998	5.6	1826	457	SURVIVE
452	T62- 1	5420379006	TOW-19	5554577728	0.0	1853	454	SURVIVE
452	ATM-11	5418478934	TOW-19	5554577728	0.0	1818	463	M+F KILL
455	T62- 2	5423278998	TOW-19	5554577728	0.0	1826	457	PRV KILL
459	SHL-21	5567177856	ATM-11	5418478934	0.0	1836	468	SURVIVE
482	SHL-21	5567177856	ATM-11	5430578816	6.0	1670	490	M+F KILL
524	SHL-21	5567177856	T62- 1	5438078759	.2	1575	532	M+F KILL
540	DRG-23	5500478093	T62- 1	5438078759	.2	913	550	PRV KILL
583	T62- 2	5469678614	SHL-21	5567177856	0.0	1234	584	SURVIVE
589	DRG-24	5495078020	ICV-15	5468878534	1.3	576	595	SURVIVE
593	T62- 2	5469678614	SHL-21	5567177856	0.0	1234	594	SURVIVE
593	DRG-23	5500478093	ICV-15	5468878534	1.3	542	604	ICV KILL
610	T62- 2	5469678614	SHL-21	5567177856	0.0	1234	611	SURVIVE
624	T62- 2	5469678614	SHL-21	5567177856	0.0	1234	625	SURVIVE
637	SHL-21	5567177856	T62- 2	5469678614	0.0	1234	643	M+F KILL
669	DRG-24	5495078020	ATM-10	5480178658	11.1	656	676	M KILL
689	DRG-24	5495078020	ATM-10	5480178658	0.0	656	697	M KILL
695	SHL-21	5567177856	ICV-14	5505578574	11.1	945	700	LOS LOST
704	T62- 7	5517878485	DRG-23	5500478093	0.0	428	705	SURVIVE
716	T62- 7	5517878485	DRG-23	5500478093	0.0	428	716	M+F KILL
751	SHL-21	5567177856	T62- 7	5528378377	5.0	650	752	M+F KILL
753	T62- 9	5492078223	DRG-24	5495078020	0.0	216	754	M+F KILL
755	DRG-24	5495078020	ATM-12	5490078145	5.0	135	757	SURVIVE
758	TOW-18	5586877903	ICV-14	5528178380	3.2	824	762	ICV KILL
770	SHL-21	5567177856	ICV-13	5502778216	3.6	738	771	SURVIVE

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
363	SHL-21	5567177856	T62- 7	5398079535	5.6	2333	379	M+F KILL
374	TOW-19	5554577728	T62- 1	5404379116	5.5	2045	383	M+F KILL
432	ATM-11	5405379077	SHL-21	5567177856	0.0	2027	445	SURVIVE
436	TOW-19	5554577728	ATM-11	5405379077	6.3	2011	445	M KILL
451	ATM-11	5405379077	SHL-21	5567177856	0.0	2027	463	SURVIVE
455	SHL-21	5567177856	ATM-11	5405379077	0.0	2027	465	SURVIVE
464	T62- 8	5419278994	TOW-19	5554577728	0.0	1853	465	SURVIVE
470	TOW-19	5554577728	ATM-11	5405379077	0.0	2011	479	M KILL
475	T62- 8	5419278994	TOW-19	5554577728	0.0	1853	477	SURVIVE
478	ATM-11	5405379077	SHL-21	5567177856	0.0	2027	491	SURVIVE
479	SHL-21	5567177856	ATM-11	5405379077	0.0	2027	489	M KILL
497	ATM-11	5405379077	SHL-21	5567177856	0.0	2027	509	SURVIVE
501	T62- 8	5419278994	TOW-19	5554577728	0.0	1853	502	SURVIVE
514	ATM-11	5405379077	SHL-21	5567177856	0.0	2027	527	SURVIVE
515	T62- 8	5419278994	TOW-19	5554577728	0.0	1853	516	SURVIVE
526	SHL-21	5567177856	IOV-15	5439373869	0.0	1697	534	IOV KILL
527	T62- 8	5419278994	TOW-19	5554577728	0.0	1853	528	SURVIVE
542	SHL-21	5567177856	ATM-11	5405379077	0.0	2027	552	SURVIVE
546	TOW-19	5554577728	ATM-11	5405379077	0.0	2011	555	SURVIVE
561	SHL-21	5567177856	ATM-11	5405379077	0.0	2027	571	M KILL
563	T62- 8	5441378798	TOW-19	5554577728	0.0	1565	570	M+F KILL
573	TOW-19	5554577728	ATM-11	5405379077	0.0	2011	578	M KILL
587	ATM-10	5431578959	SHL-21	5567177856	0.0	1747	597	SURVIVE
605	ATM-10	5431578959	SHL-21	5567177856	0.0	1747	616	SURVIVE
613	T62- 8	5444178768	SHL-21	5567177856	0.0	1530	614	SURVIVE
613	SHL-21	5567177856	T62- 8	5444178768	0.0	1530	620	M+F KILL
622	ATM-10	5431578959	SHL-21	5567177856	0.0	1747	633	SURVIVE
628	SHL-21	5567177856	ATM-11	5405379077	0.0	2027	638	M KILL
643	ATM-11	5405379077	SHL-21	5567177856	0.0	2027	655	SURVIVE
644	ATM-10	5431578959	SHL-21	5567177856	0.0	1747	655	M+F KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
647	DRG-23	5500478093	T62- 3	5474678633	5.6	538	653	SURVIVE
675	DRG-24	5495078020	T62- 2	5469778616	.5	647	682	SURVIVE
677	DRG-23	5500478093	T62- 3	5490978613	5.6	529	683	M+F KILL
690	T62- 2	5469778616	DRG-23	5500478093	0.0	507	691	M+F KILL
695	DRG-24	5495078020	T62- 2	5469778616	0.0	647	702	M+F KILL
830	ATM-10	5511878530	DRG-24	5495078020	0.0	538	833	SURVIVE
838	ATM-10	5511878530	DRG-24	5495078020	0.0	538	841	SURVIVE
849	ATM-10	5511878530	DRG-24	5495078020	0.0	538	852	M+F KILL
854	DRG-24	5495078020	ATM-10	5511878530	0.0	538	860	M KILL
941	TOW-18	5536877893	ICV-14	5539878266	5.0	651	944	SURVIVE

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
374	TOW-19	5554577728	ATM-11	5394579141	8.1	2134	384	M KILL
408	TOW-19	5554577728	ATM-11	5394579141	0.0	2134	417	SURVIVE
424	T62- 1	5416678986	TOW-19	5554577728	0.0	1867	425	SURVIVE
429	SHL-21	5567177856	ICV-15	5415778958	4.9	1872	438	SURVIVE
450	T62- 1	5416678986	TOW-19	5554577728	0.0	1867	452	M+F KILL
488	SHL-21	5567177856	ICV-15	5439778747	4.4	1555	495	SURVIVE
520	DRG-23	5500478093	T62- 1	5437673766	.2	920	530	M+F KILL
571	SHL-21	5567177856	T62- 2	5470578612	.5	1226	577	M+F KILL
581	DRG-23	5500478093	ICV-15	5476378495	5.1	466	586	ICV KILL
585	DRG-24	5495078020	T62- 8	5467578582	.5	626	592	SURVIVE
586	SHL-21	5567177856	T62- 8	5467578582	.5	1232	592	SURVIVE
596	T62- 8	5467578582	DRG-23	5500478093	0.0	590	597	M+F KILL
611	DRG-23	5500478093	T62- 8	5467578582	.5	590	617	SURVIVE
603	SHL-21	5567177856	T62- 8	5467578582	0.0	1232	609	M+F KILL
670	SHL-21	5567177856	ATM-10	5479178704	5.4	1222	676	M+F KILL
688	DRG-24	5495078020	T62- 3	5491178632	5.4	614	695	M+F KILL
695	T62- 7	5514578463	DRG-24	5495078020	0.0	485	695	SURVIVE
705	T62- 7	5514578463	DRG-24	5495078020	0.0	485	705	M+F KILL
729	SHL-21	5567177856	T62- 7	5526078367	5.0	656	730	M+F KILL
753	SHL-21	5567177856	ICV-14	5532778309	5.0	570	760	ICV KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
397	SHL-21	5567177856	ATM-11	5408779325	5.5	1969	407	M+F KILL
432	TOW-13	5554577728	T62- 1	5426278872	5.6	1719	440	M+F KILL
444	SHL-21	5567177856	T62- 7	5427579217	5.6	1948	453	SURVIVE
460	T62- 2	5422978979	TOW-13	5554577728	0.0	1815	461	SURVIVE
461	T62- 8	5421378953	TOW-13	5554577728	0.0	1809	462	M+F KILL
464	TOW-13	5554577728	T62- 8	5421378953	5.4	1809	472	SURVIVE
469	TOW-18	5536877803	T62- 7	5427579217	5.6	2129	479	M+F KILL
529	SHL-21	5567177856	ATM-10	5429079205	11.1	1330	538	M+F KILL
559	T62- 8	5445578732	SHL-21	5567177856	0.0	1498	561	SURVIVE
569	T62- 8	5445578732	SHL-21	5567177856	0.0	1498	571	SURVIVE
581	SHL-21	5567177856	T62- 8	5445578732	0.0	1498	588	M+F KILL
596	SHL-21	5567177856	ICV-15	5466078555	8.0	1229	602	ICV KILL
647	ATM-12	5430578539	SHL-21	5567177856	0.0	1527	656	M KILL
666	ATM-12	5430578539	SHL-21	5567177856	0.0	1527	675	M+F KILL
671	DRG-24	5495078020	ICV-14	5485778655	5.9	643	678	SURVIVE
702	T62- 2	5485378514	DRG-23	5500478093	0.0	446	702	M+F KILL
712	T62- 2	5485878514	DRG-24	5495078020	0.0	503	712	SURVIVE
717	DRG-23	5500478093	T62- 3	5519678398	5.0	360	721	M+F KILL
732	DRG-24	5495078020	T62- 2	5485878514	0.0	503	737	M+F KILL
755	DRG-24	5495078020	ICV-14	5524978357	5.0	451	760	SURVIVE
773	T62- 9	5483778263	DRG-24	5495078020	0.0	273	773	M+F KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
400	TOW-13	5554577728	T62- 1	5413478977	5.6	1884	409	M+F KILL
428	ATM-11	5403379031	TOW-13	5554577728	0.0	1936	440	M KILL
443	ATM-11	5403379031	TOW-13	5554577728	0.0	1936	460	M+F KILL
455	SHL-21	5567177856	ATM-11	5403379031	0.0	2016	465	M KILL
473	SHL-21	5567177856	ATM-11	5403379031	0.0	2016	482	M KILL
489	TOW-18	5536577803	T62- 3	5431973164	5.7	2061	499	SURVIVE
493	DRG-23	5500478093	T62- 8	5440178772	5.7	938	504	LOS LOST
504	ATM-10	5424973278	SHL-21	5567177856	0.0	2010	516	SURVIVE
522	ATM-10	5424973278	SHL-21	5567177856	0.0	2010	534	SURVIVE
530	SHL-21	5567177856	ATM-11	5403379031	0.0	2016	539	M+F KILL
540	ATM-10	5424973278	SHL-21	5567177856	0.0	2010	552	SURVIVE
557	ATM-10	5424973278	SHL-21	5567177856	0.0	2010	569	SURVIVE
564	DRG-23	5500478093	T62- 8	5453278713	4.9	779	572	M+F KILL
565	T62- 7	5458978831	SHL-21	5567177856	0.0	1456	566	SURVIVE
574	ATM-10	5424973278	SHL-21	5567177856	0.0	2010	586	M+F KILL
578	T62- 7	5458978831	SHL-21	5567177856	0.0	1456	579	PRV KILL
580	DRG-24	5495078020	ICV-15	5465878592	.5	642	587	SURVIVE
585	DRG-23	5500478093	ICV-15	5465878592	.5	607	592	SURVIVE
619	DRG-23	5500478093	ICV-15	5477378609	3.9	565	625	LOS LOST
642	DRG-23	5500478093	ICV-15	5470278601	2.4	591	649	ICV KILL
646	DRG-24	5495078020	ICV-15	5477378609	3.9	615	653	LOS LOST
660	T62- 7	5482178640	DRG-23	5500478093	0.0	577	661	SURVIVE
671	T62- 7	5482178640	DRG-23	5500478093	0.0	577	671	SURVIVE
681	T62- 7	5482178640	DRG-23	5500478093	0.0	577	681	M+F KILL
714	DRG-24	5495078020	T62- 7	5496978562	5.6	542	720	SURVIVE
723	T62- 7	5496978562	DRG-24	5495078020	0.0	542	723	SURVIVE
736	T62- 7	5496978562	DRG-24	5495078020	0.0	542	735	SURVIVE
737	DRG-24	5495078020	T62- 7	5496978562	0.0	542	743	M KILL
746	T62- 7	5496978562	DRG-24	5495078020	0.0	542	746	SURVIVE
751	T62- 3	5436378634	DRG-24	5495078020	0.0	621	751	M+F KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
347	TOW-19	5554577728	T62- 1	5333679195	5.6	2176	357	M+F KILL
397	TOW-19	5554577728	T62- 8	5336779147	5.6	2122	407	M+F KILL
419	ATM-11	5404473016	TOW-19	5554577728	0.0	1377	431	M+F KILL
431	TOW-19	5554577728	T62- 2	5409279080	5.6	1984	440	SURVIVE
460	SHL-21	5567177855	ATM-11	5423878843	8.4	1740	469	M+F KILL
543	DRG-23	5500478093	ICV-15	5456878606	7.0	673	550	ICV KILL
552	DRG-24	5495078020	T62- 2	5471178605	5.6	632	559	SURVIVE
579	DRG-24	5495078020	T62- 2	5472378596	.5	619	586	M+F KILL
674	SHL-21	5567177855	T62- 3	5491778585	6.5	1049	679	M+F KILL
681	DRG-23	5500478093	ATM-10	5503878556	11.1	465	686	SURVIVE
701	DRG-23	5500478093	ATM-10	5520378454	6.5	412	706	SURVIVE
717	DRG-24	5495078020	ICV-14	5528778539	11.1	619	724	SURVIVE
723	ATM-10	5520378454	DRG-24	5495078020	0.0	502	726	SURVIVE
732	ATM-10	5520378454	DRG-24	5495078020	0.0	502	735	SURVIVE
739	TOW-18	5586877803	T62- 7	5535278305	5.0	721	742	SURVIVE
742	ATM-10	5520378454	DRG-24	5495078020	0.0	502	745	M+F KILL
751	ATM-10	5520378454	DRG-23	5500478093	0.0	412	754	SURVIVE
752	DRG-23	5500478093	ICV-13	5485278312	5.0	267	755	ICV KILL
756	T62- 7	5535278305	DRG-23	5500478093	0.0	408	756	SURVIVE
759	ATM-10	5520378454	DRG-23	5500478093	0.0	412	761	SURVIVE
766	TOW-18	5586877803	T62- 7	5535278305	5.0	721	769	SURVIVE
768	SHL-21	5567177856	T62- 7	5535278305	5.0	551	769	SURVIVE
766	DRG-23	5500478093	ATM-10	5520378454	0.0	412	773	SURVIVE
768	T62- 7	5535278305	DRG-23	5500478093	0.0	408	769	SURVIVE
777	ATM-10	5520378454	DRG-23	5500478093	0.0	412	779	SURVIVE
781	T62- 7	5535278305	DRG-23	5500478093	0.0	408	781	SURVIVE
786	DRG-23	5500478093	ATM-10	5520378454	0.0	412	790	M KILL
789	T62- 9	5495178213	DRG-23	5500478093	0.0	131	789	M+F KILL
808	SHL-21	5567177856	T62- 7	5535278305	0.0	551	808	M+F KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
402	SHL-21	5567177856	ATM-11	5401179045	5.3	2042	412	M KILL
416	TOW-19	5554577728	ATM-11	5401179045	0.0	2022	425	M KILL
420	SHL-21	5567177856	ATM-11	5401179045	0.0	2042	430	M KILL
442	T62- 1	5415978991	TOW-19	5554577728	0.0	1875	443	SURVIVE
443	SHL-21	5567177856	T62- 8	5415678959	5.7	1872	452	M+F KILL
449	TOW-19	5554577728	ATM-11	5401179045	0.0	2022	458	SURVIVE
454	T62- 1	5415978991	TOW-19	5554577728	0.0	1875	456	SURVIVE
457	T62- 2	5417778984	TOW-19	5554577728	0.0	1857	458	SURVIVE
464	T62- 1	5415978991	TOW-19	5554577728	0.0	1875	466	M+F KILL
466	SHL-21	5567177856	ICV-15	5421078877	3.4	1792	475	SURVIVE
484	SHL-21	5567177856	T62- 1	5428278878	5.5	1725	492	M+F KILL
487	DRG-23	5500478093	ICV-15	5432678773	5.1	959	498	SURVIVE
492	ATM-11	5401179045	SHL-21	5567177856	0.0	2042	504	SURVIVE
505	SHL-21	5567177856	ICV-15	5432678773	5.1	1627	513	ICV KILL
510	ATM-11	5401179045	SHL-21	5567177856	0.0	2042	522	SURVIVE
521	SHL-21	5567177856	ATM-11	5401179045	0.0	2042	531	M+F KILL
583	DRG-24	5495078020	T62- 2	5468178621	.5	658	590	SURVIVE
600	DRG-23	5500478093	T62- 2	5468178621	.5	619	607	M+F KILL
625	DRG-24	5495078020	T62- 7	5485778588	3.9	576	632	SURVIVE
626	SHL-21	5567177856	T62- 7	5485778588	3.9	1095	633	SURVIVE
641	SHL-21	5567177856	T62- 7	5485778588	3.9	1095	647	LOS LOST
648	T62- 7	5485778588	DRG-23	5500478093	0.0	517	649	M+F KILL
652	DRG-24	5495078020	T62- 7	5485778588	3.9	576	659	LOS LOST
654	DRG-23	5500478093	T62- 7	5485778588	3.9	517	660	LOS LOST
655	SHL-21	5567177856	T62- 7	5485778588	0.0	1095	660	SURVIVE
658	T62- 7	5485778588	DRG-24	5495078020	0.0	576	659	SURVIVE
671	T62- 7	5485778588	DRG-24	5495078020	0.0	576	671	SURVIVE
681	T62- 7	5485778588	DRG-24	5495078020	0.0	576	681	SURVIVE
682	DRG-24	5495078020	T62- 7	5485778588	0.0	576	689	SURVIVE
689	ATM-10	5472478617	DRG-24	5495078020	0.0	633	693	SURVIVE

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
691	T62- 7	5485773588	DRG-24	5495078020	0.0	576	691	SURVIVE
694	T62- 3	5476873579	DRG-24	5495078020	0.0	538	694	M+F KILL
698	ATM-10	5472478617	SHL-21	5567177856	0.0	1215	706	SURVIVE
701	T62- 7	5485773588	SHL-21	5567177856	0.0	1095	701	SURVIVE
704	T62- 3	5476873579	SHL-21	5567177856	0.0	1156	705	SURVIVE
712	T62- 7	5485773588	SHL-21	5567177856	0.0	1095	713	SURVIVE
713	ATM-10	5472478617	SHL-21	5567177856	0.0	1215	721	M KILL
714	T62- 3	5476873579	SHL-21	5567177856	0.0	1156	715	SURVIVE
723	T62- 7	5485773588	SHL-21	5567177856	0.0	1095	724	SURVIVE
727	ATM-10	5472478617	SHL-21	5567177856	0.0	1215	735	SURVIVE
733	T62- 3	5476873579	SHL-21	5567177856	0.0	1156	734	SURVIVE
741	T62- 7	5485773588	SHL-21	5567177856	0.0	1095	742	M+F KILL

Table E-II-1a

FIRING DATA FROM DYNTACS TRIAL 96 BASE CASE

DYN TRIAL 96 REP 10

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
405	TOW-19	5554577728	ATM-11	5390073085	5.7	2132	415	LOS LOST
425	ATM-11	5401079007	TOW-19	5554577728	0.0	1997	437	M+F KILL
431	SHL-21	5567177856	T62- 1	5424973386	5.6	1756	440	SURVIVE
439	TOW-19	5554577728	ATM-11	5401079007	5.4	1997	443	M KILL
444	ATM-11	5401079007	SHL-21	5567177856	0.0	2020	456	SURVIVE
448	SHL-21	5567177856	T62- 1	5424973388	5.6	1756	457	M+F KILL
458	T62- 8	5419678974	SHL-21	5567177856	0.0	1850	460	SURVIVE
461	ATM-11	5401079007	SHL-21	5567177856	0.0	2020	473	SURVIVE
463	SHL-21	5567177856	ATM-11	5401079007	0.0	2020	478	M KILL
472	T62- 8	5419678974	SHL-21	5567177856	0.0	1850	474	SURVIVE
483	ATM-11	5401079007	SHL-21	5567177856	0.0	2020	495	SURVIVE
486	SHL-21	5567177856	ATM-11	5401079007	0.0	2020	496	M+F KILL
491	T62- 8	5419678974	SHL-21	5567177856	0.0	1850	493	SURVIVE
507	T62- 8	5419678974	SHL-21	5567177856	0.0	1850	508	SURVIVE
512	SHL-21	5567177856	T62- 8	5419678974	0.0	1850	521	M+F KILL
522	ATM-10	5430279208	SHL-21	5567177856	0.0	1924	534	SURVIVE
529	SHL-21	5567177856	ICV-15	5439178718	5.4	1543	537	ICV KILL
534	DRG-23	5500478093	ICV-15	5439178718	5.4	875	544	SURVIVE
546	ATM-10	5430279208	SHL-21	5567177856	0.0	1924	558	M+F KILL
552	TOW-18	5586377803	ICV-14	5431679290	0.0	2150	562	ICV KILL
618	DRG-24	5495378023	T62- 2	5473078527	.5	646	625	M+F KILL
664	ATM-10	5433878696	DRG-24	5495078020	0.0	685	669	SURVIVE
679	ATM-10	5433878696	DRG-24	5495078020	0.0	685	683	M+F KILL
681	DRG-23	5500478093	T62- 7	5516778419	5.0	365	685	SURVIVE
703	DRG-23	5500478093	T62- 7	5526378346	4.0	362	707	SURVIVE
725	T62- 7	5526378346	DRG-23	5500478093	0.0	362	725	M+F KILL
727	ATM-10	5509078491	DRG-23	5500478093	0.0	398	730	PRV KILL
752	TOW-18	5586377803	T62- 3	5541678379	3.9	734	755	SURVIVE

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 E REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
312	SHL-21	5567177856	ATM-10	5375180147	0.0	2383	327	SURVIVE
379	TOW-19	5554577728	T62- 2	5398173183	5.0	2151	387	M+F KILL
411	TOW-19	5554577728	T62- 1	5405479137	5.0	2044	421	SURVIVE
427	T62- 1	5415578937	TOW-19	5554577728	0.0	1882	428	SURVIVE
445	TOW-19	5554577728	T62- 1	5415578937	0.0	1882	453	M+F KILL
477	TOW-19	5554577728	ATM-11	5428478852	4.9	1689	485	SURVIVE
478	ATM-11	5428478852	TOW-19	5554577728	0.0	1689	488	M+F KILL
480	SHL-21	5567177856	ATM-11	5428478852	4.9	1708	488	SURVIVE
493	SHL-21	5567177856	ATM-11	5428478852	0.0	1708	506	M KILL
543	SHL-21	5567177856	ATM-11	5428478852	0.0	1708	556	M KILL
561	ATM-11	5428478852	SHL-21	5567177856	0.0	1708	572	M KILL
567	SHL-21	5567177856	ATM-11	5428478852	0.0	1708	575	M+F KILL
583	DRG-23	5500478093	T62- 5	5469578617	.5	609	589	SURVIVE
586	DRG-24	5495078020	T62- 8	5469578617	.5	649	593	SURVIVE
591	T62- 8	5469578617	DRG-23	5500478093	0.0	609	592	M+F KILL
601	T62- 8	5469578617	DRG-24	5495078020	0.0	649	602	SURVIVE
611	T62- 8	5469578617	DRG-24	5495078020	0.0	649	612	SURVIVE
612	DRG-24	5495078020	T62- 8	5469578617	0.0	649	619	SURVIVE
614	SHL-21	5567177856	ICV-15	5469078536	.4	1193	620	ICV KILL
626	T62- 8	5469578617	DRG-24	5495078020	0.0	649	635	SURVIVE
633	SHL-21	5567177856	ATM-10	5472378732	0.0	1325	639	M+F KILL
633	T62- 8	5469578617	DRG-24	5495078020	0.0	649	639	M+F KILL
675	SHL-21	5567177856	T62- 8	5495078457	5.0	938	680	M+F KILL
678	T62- 3	5497178599	SHL-21	5567177856	0.0	1021	679	SURVIVE
704	SHL-21	5567177856	ICV-14	5512878470	11.1	819	708	ICV KILL
707	T62- 3	5497178599	SHL-21	5567177856	0.0	1021	708	SURVIVE
717	T62- 3	5497178599	SHL-21	5567177856	0.0	1021	718	SURVIVE
732	T62- 3	5497178599	SHL-21	5567177856	0.0	1021	733	SURVIVE
743	T62- 3	5497178599	SHL-21	5567177856	0.0	1021	750	M+F KILL
823	TOW-18	5586377803	T62- 3	5550078319	8.8	635	825	SURVIVE

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 E REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
253	SHL-21	5567177856	ATM-10	5375190147	0.0	2938	268	M+F KILL
323	SHL-21	5567177856	T62- 1	5391379341	5.6	2331	334	SURVIVE
392	TOW-19	5554577728	T62- 1	5411379107	5.6	1938	401	M+F KILL
424	ATM-11	5407279053	TOW-19	5554577728	0.0	1981	436	SURVIVE
425	TOW-19	5554577728	ATM-11	5407279053	6.7	1981	434	M KILL
452	ATM-11	5407279053	TOW-19	5554577728	0.0	1981	464	SURVIVE
458	TOW-19	5554577728	ATM-11	5407279053	0.0	1981	467	M KILL
460	T62- 8	5418979001	TOW-19	5554577728	0.0	1859	461	SURVIVE
461	SHL-21	5567177856	ICV-15	5417578945	.9	1851	470	SURVIVE
467	TOW-13	5536877803	T62- 3	5417079308	5.4	2269	477	M+F KILL
469	T62- 2	5420579026	TOW-19	5554577728	0.0	1865	471	SURVIVE
486	T62- 6	5418979001	TOW-19	5554577728	0.0	1859	487	M+F KILL
501	TOW-13	5536877803	ICV-14	5421279302	6.4	2234	511	ICV KILL
538	SHL-21	5567177856	ICV-15	5425478844	3.9	1719	546	SURVIVE
552	DRG-23	5500478097	ICV-15	5435373746	6.6	922	562	ICV KILL
512	T62- 7	5479878681	SHL-21	5567177856	0.0	1201	513	SURVIVE
622	T62- 7	5479578681	SHL-21	5567177856	0.0	1201	623	SURVIVE
631	DRG-23	5500478093	T62- 8	5467073598	1.1	606	638	SURVIVE
633	T62- 7	5479878681	SHL-21	5567177856	0.0	1201	633	M+F KILL
647	DRG-24	5495078020	T62- 8	5467078598	1.1	642	654	M KILL
656	DRG-23	5500478093	T62- 8	5467078598	0.7	636	662	M+F KILL
673	DRG-24	5495078020	T62- 2	5459178625	.5	658	685	M+F KILL
726	DRG-24	5495078020	T62- 7	5517578440	5.0	477	731	M+F KILL
763	DRG-23	5500478093	ATM-12	5484678173	5.0	177	765	M KILL
780	DRG-23	5500478093	ATM-12	5484678173	3.0	177	782	M+F KILL
789	DRG-24	5495078020	ICV-13	5489978281	5.0	266	792	SURVIVE
795	DRG-23	5500478093	ICV-13	5497478109	6.5	33	796	ICV KILL
795	T62- 9	5499378187	DRG-23	5500478093	0.0	94	795	SURVIVE
805	DRG-24	5495078020	T62- 9	5499878187	0.0	174	807	SURVIVE
811	T62- 9	5499378187	DRG-23	5500478093	0.0	94	811	M+F KILL

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 E REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
841	ORG-24	5435078020	T62- 9	5499878187	0.0	174	843	F KILL

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 : REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
369	SHL-21	5567177856	ATM-10	5375130147	0.0	2938	323	SURVIVE
384	TOW-19	5554577728	T62- 2	5395978162	5.5	2138	334	SURVIVE
419	TOW-13	5554577728	T62- 2	5408478087	5.6	1935	426	M+F KILL
422	ATM-11	5404278019	TOW-19	5554577728	0.0	1931	434	M+F KILL
425	SHL-21	5567177856	T62- 6	5406978062	5.7	2035	434	LOS LOST
444	SHL-21	5567177856	ATM-11	5423978846	8.5	1741	453	M KILL
465	SHL-21	5567177856	ATM-11	5423978846	0.0	1741	474	M KILL
515	SHL-21	5567177856	ATM-11	5423978846	0.0	1741	524	M+F KILL
582	DRG-23	5500478093	T62- 5	5472578627	.5	603	583	SURVIVE
584	DRG-24	5495078023	ICV-15	5468278560	.3	603	591	SURVIVE
589	T62- 7	5464578740	SHL-21	5567177856	0.0	1353	590	SURVIVE
592	SHL-21	5567177856	T62- 8	5472578627	.5	1220	598	M+F KILL
600	T62- 1	5444278770	SHL-21	5567177856	0.0	1531	602	SURVIVE
602	T62- 7	5464578740	SHL-21	5567177856	0.0	1353	603	SURVIVE
606	DRG-23	5500478093	ICV-15	5469578553	.5	554	613	SURVIVE
612	TOW-18	5586877373	ICV-14	5452378067	0.0	1843	620	SURVIVE
615	T62- 1	5444278770	SHL-21	5567177856	0.0	1531	616	SURVIVE
616	SHL-21	5567177856	ICV-15	5469578553	.5	1139	622	ICV KILL
617	T62- 7	5464578740	SHL-21	5567177856	0.0	1353	618	SURVIVE
627	T62- 7	5464578740	SHL-21	5567177856	0.0	1353	628	SURVIVE
636	T62- 1	5444278770	SHL-21	5567177856	0.0	1531	637	SURVIVE
640	T62- 7	5464578740	SHL-21	5567177856	0.0	1353	641	M+F KILL
716	DRG-23	5500478093	ATM-10	5483378675	5.7	607	722	SURVIVE
728	DRG-24	5495078023	T62- 7	5505178509	5.5	499	733	SURVIVE
739	DRG-23	5500473093	ATM-10	5483378675	5.7	607	746	LOS LOST
750	DRG-24	5495078023	T62- 7	5517078417	5.0	455	755	SURVIVE
762	DRG-23	5500478093	ATM-10	5510578467	11.1	388	757	SURVIVE
785	DRG-23	5500478093	T62- 9	5487778244	5.0	197	787	M+F KILL
786	TOW-18	5586877373	T62- 3	5537478413	5.0	785	790	M+F KILL
792	T62- 7	5529373326	DRG-23	5500478093	0.0	369	732	SURVIVE

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 E REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
803	DRG-24	5495078020	T62- 7	5529073326	0.0	458	808	M+F KILL
821	DRG-24	5495878020	ATM-10	5537478262	5.0	488	827	M KILL
835	TOW-18	5586877803	ICV-14	5547278337	5.8	667	838	SURVIVE
838	ATM-12	5486578160	DRG-23	5500478093	0.0	154	839	SURVIVE
840	DRG-24	5495078020	ATM-10	5537478262	0.0	485	845	M KILL
845	ATM-12	5486578160	DRG-23	5500478093	0.0	154	846	SURVIVE
859	ATM-12	5486578160	DRG-23	5500478093	0.0	154	860	M+F KILL
871	ATM-12	5486578160	DRG-24	5495078020	0.0	163	872	SURVIVE
882	TOW-18	5586877803	ICV-14	5547278307	.5	643	885	ICV KILL

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 - RTP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
368	SHL-21	5567177856	T62- 7	5398079535	5.6	2383	379	M+F KILL
374	TOW-19	5554577728	T62- 1	5404379116	5.6	2045	383	M+F KILL
419	ATM-11	5404579055	SHL-21	5567177856	0.0	2020	431	M KILL
424	SHL-21	5567177856	ATM-10	5401179494	0.0	2331	435	SURVIVE
427	TOW-19	5554577728	T62- 2	5421579009	5.6	1846	435	SURVIVE
436	ATM-11	5404579055	SHL-21	5567177856	0.0	2020	449	SURVIVE
447	SHL-21	5567177856	ATM-10	5401179494	0.0	2331	459	M KILL
457	ATM-11	5404579055	SHL-21	5567177856	0.0	2020	469	SURVIVE
459	TOW-19	5554577728	T62- 2	5421579009	5.6	1846	466	M+F KILL
467	TOW-18	5536877803	T62- 3	5418979275	5.6	2233	476	SURVIVE
477	ATM-11	5404579055	SHL-21	5567177856	0.0	2020	489	SURVIVE
489	T62- 8	5433378895	TOW-19	5554577728	0.0	1582	493	SURVIVE
492	TOW-19	5554577728	T62- 8	5433378895	5.6	1552	499	LOS LIMIT
494	ATM-11	5404579055	SHL-21	5567177856	0.0	2020	505	SURVIVE
501	T62- 8	5433378895	TOW-19	5554577728	0.0	1532	502	SURVIVE
502	TOW-18	5536877803	T62- 3	5427579175	5.5	2102	511	SURVIVE
523	TOW-19	5554577728	T62- 8	5433378895	0.0	1532	531	M+F KILL
532	SHL-21	5567177856	T62- 3	5439179053	5.6	1752	540	SURVIVE
557	TOW-19	5554577728	ICV-15	5415379026	0.0	1895	565	ICV KILL
593	SHL-21	5567177856	ICV-14	5439179018	7.0	1728	601	SURVIVE
632	TOW-19	5554577728	T62- 3	5462378687	5.6	1197	637	F KILL
639	SHL-21	5567177856	T62- 3	5462378687	5.6	1154	644	M+F KILL
670	DRG-24	5495078020	ATM-11	5464578610	.5	664	677	M+F KILL
726	DRG-23	5500478033	ICV-14	5499778584	5.6	492	732	ICV KILL
727	DRG-24	5495078020	ICV-14	5499778584	5.6	566	734	SURVIVE
749	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	760	SURVIVE
765	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	775	SURVIVE
785	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	795	SURVIVE
786	SHL-21	5567177856	ICV-13	5479278333	5.9	1010	791	ICV KILL
802	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	812	SURVIVE

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 E REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
803	DRG-23	5500478093	T62- 9	5487978246	5.0	198	805	SURVIVE
805	DRG-24	5495078020	T62- 9	5487978246	5.0	236	807	SURVIVE
817	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	828	SURVIVE
825	DRG-23	5500478093	T62- 9	5487978246	5.0	198	827	SURVIVE
829	SHL-21	5567177856	ATM-10	5401179494	0.0	2331	840	SURVIVE
834	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	844	SURVIVE
843	DRG-23	5500478093	ATM-12	5487478159	5.0	145	844	M KILL
843	ATM-12	5487478159	TOW-19	5554577728	0.0	736	848	M+F KILL
846	DRG-24	5495078020	T62- 9	5487978246	5.0	236	849	M+F KILL
849	SHL-21	5567177856	ATM-10	5401179494	0.0	2331	860	M KILL
852	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	863	SURVIVE
857	DRG-23	5500478093	ATM-12	5487478159	0.0	145	859	M+F KILL
869	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	880	SURVIVE
871	SHL-21	5567177856	ATM-10	5401179494	0.0	2331	883	SURVIVE
886	ATM-10	5401179494	DRG-24	5495078020	0.0	1747	896	SURVIVE
900	DRG-24	5495078020	T62- 5	5496478203	5.0	184	902	M+F KILL

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 E REP [illegible]

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
374	TOW-13	5554577728	ATM-11	5394579141	8.1	2134	384	M KILL
408	TOW-13	5554577728	ATM-11	5394579141	0.0	2134	417	SURVIVE
423	T62- 1	5416578936	TOW-13	5554577726	0.0	1367	429	SURVIVE
437	SHL-21	5567177856	T62- 2	5421378968	5.6	1833	445	F KILL
445	T62- 1	5416578985	TOW-13	5554577726	0.0	1367	447	SURVIVE
454	SHL-21	5567177856	T62- 2	5421378968	5.6	1833	463	M+F KILL
456	T62- 1	5416578936	TOW-13	5554577728	0.0	1367	460	SURVIVE
462	TOW-13	5554577728	T62- 8	5419778942	5.3	1814	470	SURVIVE
463	T62- 8	5419778942	TOW-13	5554577728	0.0	1814	464	M+F KILL
471	SHL-21	5567177856	ICV-15	5423378813	4.3	1728	480	SURVIVE
498	SHL-21	5567177856	T62- 6	5473178855	5.6	1671	507	LOS LOST
525	SHL-21	5567177856	ICV-15	5442478726	5.6	1520	533	LOS LOST
527	DRG-23	5530478093	T62- 1	5437373762	5.6	913	537	LOS LOST
542	SHL-21	5567177856	ICV-15	5455378640	5.9	1361	548	ICV KILL
559	DRG-23	5530478093	T62- 1	5437973760	.2	914	560	M+F KILL
563	ATM-12	5429778554	SHL-21	5567177856	0.0	1541	572	SURVIVE
577	ATM-12	5429778554	SHL-21	5567177856	0.0	1541	586	SURVIVE
583	SHL-21	5567177856	T62- 3	5471878598	.5	1207	594	M+F KILL
592	ATM-12	5429778554	SHL-21	5567177856	0.0	1541	602	SURVIVE
600	DRG-24	5495078020	T62- 7	5484978709	5.6	697	607	SURVIVE
608	ATM-12	5429778554	SHL-21	5567177856	0.0	1541	617	M+F KILL
610	T62- 7	5484978709	DRG-24	5495078020	0.0	697	610	SURVIVE
619	SHL-21	5567177856	ATM-12	5429778554	0.0	1541	627	SURVIVE
634	DRG-24	5495078020	T62- 7	5484978709	0.0	697	642	F KILL
680	DRG-24	5495078020	T62- 7	5484978709	0.0	697	688	M+F KILL
725	T62- 3	5512778505	DRG-24	5495078020	0.0	516	725	SURVIVE
735	T62- 3	5512778505	DRG-24	5495078020	0.0	516	735	SURVIVE
753	T62- 3	5512778505	DRG-24	5495078020	0.0	516	758	SURVIVE
762	DRG-24	5495078020	ATM-12	5438078158	[illegible]	154	764	SURVIVE
765	T62- 3	5512778505	DRG-24	5495078020	0.0	516	758	SURVIVE

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 E REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
769	DRG-23	5500478093	T62- 9	5488178248	5.0	198	771	SURVIVE
770	T62- 9	5488178248	DRG-23	5500478093	0.0	198	771	M+F KILL
777	DRG-24	5495078020	ATM-12	5488078158	5.0	154	779	SURVIVE
778	T62- 3	5512776505	DRG-24	5495078020	0.0	516	779	SURVIVE
781	T62- 9	5488178248	DRG-24	5495078020	0.0	238	781	SURVIVE
792	T62- 9	5488178248	DRG-24	5495078020	0.0	238	792	M+F KILL

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 F REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
397	SHL-21	5567177356	ATM-11	5490773025	6.6	1969	407	M+F KILL
432	TOW-19	5554577728	T62- 1	5426278872	5.5	1719	440	M+F KILL
444	SHL-21	5567177356	T62- 7	5427678217	5.5	1948	453	SURVIVE
460	T62- 2	5422978979	TOW-19	5554577728	0.0	1815	461	SURVIVE
464	TOW-19	5554577728	T62- 5	5421378953	0.0	1809	472	SURVIVE
463	T62- 8	5421378953	TOW-19	5554577728	0.0	1809	469	SURVIVE
463	TOW-13	5586377303	T62- 7	5427678217	5.5	2129	473	M+F KILL
472	T62- 8	5421378353	TOW-19	5554577728	0.0	1809	479	SURVIVE
480	T62- 2	5422378379	TOW-19	5554577728	0.0	1815	481	SURVIVE
496	TOW-19	5554577728	T62- 8	5421378953	0.0	1809	504	M+F KILL
506	T62- 2	5422978979	TOW-19	5554577728	0.0	1815	507	SURVIVE
523	ATM-10	5429079205	SHL-21	5567177356	0.0	1930	535	SURVIVE
526	T62- 2	5422978979	TOW-19	5554577728	0.0	1815	527	SURVIVE
528	TOW-19	5554577728	T62- 2	5422978979	0.0	1815	537	SURVIVE
540	ATM-10	5429079205	SHL-21	5567177856	0.0	1930	552	M+F KILL
545	TOW-13	5586377303	ATM-10	5429079205	0.0	2111	558	M+F KILL
548	T62- 2	5422978979	TOW-19	5554577728	0.0	1815	549	M KILL
569	TOW-19	5554577728	T62- 2	5422978979	0.0	1815	577	SURVIVE
674	DRG-24	5495078020	T62- 3	5495778542	5.6	522	680	SURVIVE
682	DRG-23	5500478093	ICV-15	5481078440	6.2	397	695	SURVIVE
705	DRG-24	5495078020	T62- 3	5509678446	5.6	451	710	M+F KILL
714	TOW-19	5554577728	T62- 2	5497478422	5.0	393	718	SURVIVE
728	DRG-24	5495078020	ATM-12	5484378174	5.1	137	731	M KILL
734	DRG-23	5500478093	T62- 2	5497478422	5.0	331	738	M+F KILL
744	DRG-24	5495078020	ATM-12	5484378174	0.0	187	746	M+F KILL
745	T62- 9	5485378259	TOW-19	5554577728	0.0	872	746	M+F KILL
751	DRG-23	5500478093	ICV-15	5505678366	5.0	278	754	SURVIVE
759	DRG-24	5495078020	ICV-13	5490278145	4.4	134	760	SURVIVE
773	DRG-24	5495078020	ICV-13	5490278145	4.4	134	779	SURVIVE
786	T62- 9	5498778192	DRG-23	5500478093	0.0	131	786	M+F KILL

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 F REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
799	T62- 3	5498778192	DRG-24	5495078020	0.0	176	799	M+F KILL

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 F REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
40?	TOW-19	5554577728	T62- 1	5413473977	5.6	1864	439	M+F KILL
437	SHL-21	5567177856	T62- 8	5418173977	5.5	1864	446	LOS LOST
453	TOW-19	5554577728	ATM-11	5415278938	5.0	1845	467	M KILL
459	SHL-21	5567177856	ATM-11	5415278938	0.0	1865	468	M KILL
475	SHL-21	5567177856	ATM-11	5415278938	0.0	1865	485	M+F KILL
491	TOW-19	5554577728	ATM-11	5415278938	0.0	1845	499	PRV KILL
497	DRG-23	5500478093	ICV-15	5439278766	6.2	909	507	LOS LOST
530	SHL-21	5567177856	ICV-14	5425779230	7.5	1950	540	ICV KILL
560	T62- 7	545487384	SHL-21	5567177856	0.0	1494	551	SURVIVE
573	TOW-19	5554577728	T62- 8	5468178520	.3	1241	578	M+F KILL
573	T62- 7	5454873842	SHL-21	5567177856	0.0	1494	579	M+F KILL
581	DRG-24	5495078020	ICV-15	5465273578	.3	633	588	ICV KILL
598	T62- 2	5469778645	DRG-23	5500478093	0.0	631	599	SURVIVE
608	T62- 2	5469778645	DRG-23	5500478093	0.0	631	609	M+F KILL
619	DRG-23	5500478093	T62- 2	5469778645	0.0	631	626	SURVIVE
628	DRG-24	5495078020	T62- 2	5471278640	.5	664	635	LOS LOST
652	DRG-24	5495078020	T62- 2	5471278640	.5	664	659	SURVIVE
694	DRG-24	5495078020	T62- 2	5437478362	5.5	547	700	M+F KILL
710	TOW-19	5554577728	ATM-10	5479278623	6.2	1169	715	M KILL
729	T62- 7	5515978400	DRG-24	5495078020	0.0	434	729	M+F KILL
733	ATM-10	5479278623	TOW-19	5554577728	0.0	1169	740	M+F KILL
742	TOW-19	5554577728	ATM-10	5479278623	0.0	1169	747	M KILL
809	TOW-18	5585877803	T62- 3	5544878348	8.7	689	813	SURVIVE

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 F REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
347	TOW-19	5554577728	T62- 1	5393679195	5.6	2176	357	M+F KILL
397	TOW-19	5554577728	T62- 8	5396779147	5.5	2122	407	M+F KILL
431	TOW-19	5554577728	T62- 2	5409279083	5.6	1984	440	M+F KILL
464	TOW-19	5554577728	ICV-15	5423278972	8.3	1808	472	ICV KILL
585	DRG-24	5495078020	ATM-11	5471478652	.5	674	593	M KILL
589	SHL-21	5567177856	T62- 7	5483078715	5.6	1202	595	LOS LOST
606	DRG-24	5495078020	ATM-11	5471478652	0.0	674	613	SURVIVE
656	DRG-24	5495078020	T62- 3	5498878659	7.8	640	663	SURVIVE
691	DRG-23	5500478093	T62- 3	5528578558	11.1	544	697	SURVIVE
698	DRG-24	5495078020	T62- 3	5528578558	11.1	635	705	SURVIVE
705	TOW-18	5586677803	T62- 3	5538378449	4.9	39	709	M+F KILL
715	ATM-11	5471478652	DRG-23	5500478093	0.0	630	718	M+F KILL
720	ATM-10	5525478409	DRG-24	5495078020	0.0	495	723	SURVIVE
728	ATM-10	5525478409	DRG-24	5495078020	0.0	495	731	SURVIVE
739	SHL-21	5567177856	T62- 7	5539978261	5.0	488	740	SURVIVE
743	ATM-10	5525478409	DRG-24	5495078020	0.0	495	746	SURVIVE
747	DRG-24	5495078020	ATM-12	5488278153	5.0	148	748	SURVIVE
752	TOW-19	5554577728	T62- 9	5490578230	5.0	813	755	M+F KILL
754	SHL-21	5567177856	T62- 7	5539978261	5.0	488	755	M KILL
754	ATM-11	5471478652	DRG-24	5495078020	0.0	674	758	SURVIVE
755	TOW-18	5586877803	T62- 7	5539978261	5.0	656	758	SURVIVE
755	ATM-10	5525478409	DRG-24	5495078020	0.0	495	758	SURVIVE
757	ATM-12	5488278153	DRG-24	5495078020	0.0	148	758	SURVIVE
760	T62- 7	5539978261	DRG-24	5495078020	0.0	510	760	SURVIVE
763	ATM-10	5525478409	DRG-24	5495078020	0.0	495	766	SURVIVE
767	ATM-11	5471478652	DRG-24	5495078020	0.0	674	771	SURVIVE
772	ATM-12	5488278153	DRG-24	5495078020	0.0	148	773	M+F KILL
779	TOW-19	5554577728	T62- 5	5483378264	5.0	891	783	SURVIVE
782	TOW-18	5586377803	T62- 7	5539978261	0.0	656	785	M+F KILL
797	SHL-21	5567177856	ICV-14	5548278347	6.3	527	799	ICV KILL

Table E-II-1b

FIRING DATA FROM DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 E REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
807	RPG-24	5495078020	ATM-12	5488278153	0.0	143	809	M KILL
810	TOW-19	5554577728	T62- 5	5496375200	5.0	745	813	M+F KILL
809	TOW-18	5536377803	ATM-10	5535378301	0.0	714	813	M+F KILL
837	TOW-19	5554577728	ICV-13	5501178181	4.9	790	841	ICV KILL

Table E-II-1b

FIRING DATA FOR DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
402	SHL-21	5567177856	ATM-11	5401179045	5.3	2042	412	M KILL
416	TOW-13	5554577723	ATM-11	5401179045	0.0	2022	425	M KILL
420	SHL-21	5567177856	ATM-11	5401179045	0.0	2042	430	M KILL
443	TOW-13	5554577723	ATM-11	5401179045	0.0	2022	453	SURVIVE
455	T62- 2	5417773234	TOW-13	5554577723	0.0	1357	456	M+F KILL
473	SHL-21	5567177856	T62- 1	5439773305	5.8	1539	437	M+F KILL
512	SHL-21	5567177856	T62- 5	5435273305	8.4	1525	520	SURVIVE
552	ATM-11	5401179045	SHL-21	5567177856	0.0	2042	564	M+F KILL
591	DRG-24	5495078020	T62- 8	5466778593	.9	633	599	SURVIVE
613	T62- 2	5468178621	DRG-23	5500478093	0.0	619	614	SURVIVE
617	DRG-23	5500478093	T62- 3	5466778593	.0	603	623	SURVIVE
619	DRG-24	5495078020	T62- 8	5466778593	.8	639	625	SURVIVE
624	T62- 2	5468178621	DRG-23	5500478093	0.0	619	624	SURVIVE
640	T62- 2	5468178621	DRG-23	5500478093	0.0	619	640	M+F KILL
642	DRG-24	5495078020	T62- 2	5468178621	0.0	658	650	SURVIVE
646	DRG-23	5500478093	T62- 8	5466778593	0.0	603	653	SURVIVE
650	T62- 2	5468178621	DRG-24	5495078020	0.0	658	650	SURVIVE
651	T62- 7	5433878699	DRG-24	5495078020	0.0	633	652	SURVIVE
663	DRG-24	5495078020	T62- 2	5468178621	0.0	658	670	M+F KILL
665	T62- 7	5433878699	DRG-24	5495078020	0.0	633	666	SURVIVE
673	T62- 8	5466778593	DRG-24	5495078020	0.0	639	674	SURVIVE
675	T62- 7	5483878699	DRG-24	5495078020	0.0	688	676	SURVIVE
690	T62- 8	5466778593	DRG-24	5495078020	0.0	639	690	M+F KILL
693	DRG-24	5495078020	ICV-15	5475478437	3.3	512	699	SURVIVE
764	TOW-13	5536877803	T62- 3	5541678392	5.0	743	757	SURVIVE
796	TOW-13	5536377803	T62- 3	5541678392	5.0	743	800	M+F KILL
32	TOW-13	5536377303	ICV-14	5544673366	0.0	704	827	SURVIVE

Table E-II-1b

FIRING DATA FOR DYNTACS TRIAL 96 EXCURSION

DYN TRIAL 96 F REP 10

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
405	TOW-19	5554577728	ATM-11	5390079365	5.7	2132	415	LOS LOST
427	ATM-11	5401073007	TOW-19	5554577728	[illegible]	1997	439	M+F KILL
435	SHL-21	5567177856	T62- 1	5424973388	5.6	1756	447	SURVIVE
439	TOW-19	5554577728	ATM-11	5401073007	5.4	1997	448	M KILL
456	SHL-21	5567177856	T62- 1	5439073799	[illegible]	1590	464	M+F KILL
476	SHL-21	5567177856	T62- 6	5428773871	5.2	1717	485	SURVIVE
502	SHL-21	5567177856	ICV-15	5440274746	6.1	1550	509	ICV KILL
563	ATM-11	5431079007	SHL-21	5567177856	0.0	2020	580	M+F KILL
579	DRG-23	5500478093	T62- 8	546937[illegible]590	.3	536	585	M+F KILL
580	DRG-24	5495078020	T62- 2	5470178618	.5	549	587	SURVIVE
607	DRG-23	5500478093	T62- 2	5470178618	.5	605	614	LOS LOST
617	DRG-24	5495078020	T62- 2	5471478611	.5	636	624	M KILL
624	T62- 2	5471478611	DRG-23	5500478093	0.0	594	625	SURVIVE
630	DRG-23	5500478093	T62- 2	5471478611	0.0	594	636	SURVIVE
643	DRG-24	5495078020	T62- 2	5471478611	0.0	536	650	M+F KILL
675	DRG-23	5500478093	T62- 7	5507978482	5.6	396	679	M+F KILL
689	DRG-24	5495078020	T62- 3	5497278562	0.0	543	695	M+F KILL
692	DRG-23	5500478093	T62- 3	5497278562	5.4	471	696	PRV KILL
709	DRG-24	5495078020	ATM-10	5499678549	5.6	531	715	SURVIVE
711	DRG-23	5500478093	ATM-10	5499678549	5.6	456	715	M KILL
718	ATM-10	5499678549	DRG-23	5500478093	0.0	456	720	SURVIVE
732	ATM-10	5499678549	DRG-23	5500478093	0.0	456	734	M+F KILL
735	DRG-24	5495078020	ATM-10	5499678549	0.0	531	740	M KILL
740	ATM-10	5499678549	DRG-24	5495078020	0.0	531	744	SURVIVE
756	ATM-10	5499678549	DRG-24	5495078020	0.0	531	759	SURVIVE
760	T62- 3	5541673379	TOW-18	5586877863	0.0	734	761	M+F KILL
769	ATM-10	5499678549	DRG-24	5495078020	0.0	531	772	SURVIVE
783	ATM-10	5499678549	DRG-24	5495078020	0.0	531	786	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 95 REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
397	SHL-21	5569277879	T62- 7	5435479229	6.7	1960	406	M+F KILL
414	SHL-21	5569277879	T62- 3	5438579096	6.7	1843	422	M+F KILL
435	SHL-21	5569277879	ATM-10	5454179044	6.7	1697	443	M KILL
445	ATM-12	54 6078857	SHL-21	5569277879	[illegible]	19 9	454	M+F KILL
451	SHL-21	5569277879	ATM-12	54 6078857	0.0	1909	460	LOS LOST
519	TOW-19	5557777753	ATM-11	5409179007	5.0	2006	531	M+F KILL
546	TOW-19	5557777753	T62- 2	5413278883	5.0	1860	555	M+F KILL
558	DRG-24	5495877972	ICV-14	5486478663	[illegible]	655	565	ICV KILL
570	TOW-19	5557777753	T62- 8	5417378758	5.0	1744	578	M+F KILL
573	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	574	SURVIVE
587	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	588	SURVIVE
589	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	597	M+F KILL
613	TOW-19	5557777753	ICV-15	543 7884	[illegible]	1685	621	SURVIVE
673	TOW-19	5557777753	ICV-15	5443978732	5.0	1539	680	SURVIVE
712	DRG-24	5495877972	ICV-15	5453178660	0.0	796	720	SURVIVE
733	DRG-24	5495877972	ICV-15	5453178660	0.0	796	741	SURVIVE
755	DRG-24	5495877972	ICV-15	5453178660	0.0	796	763	SURVIVE
776	DRG-24	5495877972	ICV-15	545317866	[illegible]	796	784	SURVIVE
781	TOW-19	5557777753	T62- 9	5435778543	3.9	1477	788	M+F KILL
797	DRG-24	5495877972	ICV-15	5456878628	5.0	796	805	SURVIVE
816	TOW-19	5557777753	T62- 5	5436678471	0.0	1390	823	SURVIVE
82	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	821	SURVIVE
829	DRG-24	5495877972	ICV-15	5469478529	5.0	651	836	SURVIVE
837	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	838	SURVIVE
849	DRG-24	5495877972	ICV-15	5476578478	5.0	542	855	SURVIVE
851	TOW-19	5557777753	T62- 5	5436678471	0.0	1390	858	M KILL
871	DRG-24	5495877972	ICV-15	5483778426	5.0	462	876	SURVIVE
872	TOW-19	5557777753	ICV-13	5447478576	0.0	1390	879	ICV KILL
877	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	883	LOS LOST
880	DRG-23	5504478127	ICV-15	5486178408	0.0	330	884	ICV KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 95 REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
1 .7	DRG-23	5534478127	ATM-12	5475478360	0.0	376	1011	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
419	SHL-21	5569277879	T62- 1	5385079298	0.0	2378	430	LOS LOST
441	SHL-21	5569277879	T62- 7	5453978960	6.7	1638	449	F KILL
447	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	456	M+F KILL
533	DRG-24	5495877972	T62- 3	5475678558	0.0	655	540	M+F KILL
556	DRG-23	5504478127	ATM-1	5482878628	0.0	537	562	SURVIVE
561	TOW-19	5557777753	T62- 1	5425778755	0.0	1683	569	SURVIVE
567	ATM-1	5482878628	DRG-23	5504478127	0.0	537	569	SURVIVE
57[illegible]	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	571	SURVIVE
575	ATM-10	5482878628	DRG-23	5504478127	0.0	537	577	M+F KILL
577	DRG-24	5495877972	ICV-14	5486478663	0.0	655	584	ICV KILL
585	ATM-10	5482878628	DRG-24	5495877972	0.0	655	588	SURVIVE
586	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	587	SURVIVE
593	ATM-10	5482878628	DRG-24	5495877972	0.0	655	596	SURVIVE
593	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	601	M+F KILL
598	T62- 2	5422678770	TOW-19	5557777753	0.0	1685	599	SURVIVE
601	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	6[illegible]2	M KILL
601	DRG-24	5495877972	ATM-11	5482878628	0.0	655	6[illegible]8	M KILL
6[illegible]1	ATM-11	5426478675	TOW-19	5557777753	0.0	1685	609	LOS LOST
6[illegible]2	ATM-1	5482878628	DRG-24	5495877972	0.0	655	605	SURVIVE
709	DRG-24	5495877972	T62- 2	5446078590	0.0	796	717	SURVIVE
715	T62- 2	5446078590	DRG-24	5495877972	0.0	796	715	SURVIVE
717	ATM-11	5449578625	DRG-24	5495877972	0.0	796	721	M+F KILL
718	T62- 8	5442478555	DRG-24	5495877972	0.0	796	718	PRV KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
424	SHL-21	5569277879	ATM-12	5401178892	6.7	2028	434	M+F KILL
443	SHL-21	5569277879	ICV-13	5409678892	0.0	1909	452	ICV KILL
449	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	450	SURVIVE
451	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	452	SURVIVE
457	SHL-21	5569277879	T62- 9	5402478822	0.0	1909	4[illegible]	M+F KILL
467	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	468	SURVIVE
478	SHL-21	5569277879	T62- 5	5398878787	0.0	1909	477	SURVIVE
488	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	4[illegible]	SURVIVE
502	SHL-21	5569277879	T62- 5	5398878787	0.0	1909	511	F KILL
504	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	515	SURVIVE
517	SHL-21	5569277879	T62- 7	5479278593	0.0	1146	522	SURVIVE
524	DRG-24	5495877972	T62- 3	5475678558	0.0	655	531	SURVIVE
533	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	534	SURVIVE
535	T62- 3	5475678558	DRG-24	5495877972	0.0	655	535	SURVIVE
540	TOW-19	5557777753	T62- 2	5411278905	5.0	1889	549	M+F KILL
541	DRG-23	5504478127	ATM-1	5482878628	0.0	537	547	M KILL
544	DRG-24	5495877972	T62- 3	5475678558	0.0	655	551	LOS LOST
547	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	548	SURVIVE
549	T62- 3	5475678558	DRG-24	5495877972	0.0	655	549	M+F KILL
554	T62- 3	5475678558	DRG-23	5504478127	0.0	537	554	M+F KILL
556	SHL-21	5569277879	T62- 7	5479278593	0.0	1146	561	F KILL
561	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	562	SURVIVE
564	TOW-19	5557777753	T62- 8	5415478781	5.0	1773	572	M+F KILL
568	T62- 3	5475678558	SHL-21	5569277879	0.0	1146	569	M+F KILL
581	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	582	SURVIVE
587	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	595	F KILL
592	ATM-11	5426478805	TOW-19	5557777753	0.0	1685	600	SURVIVE
606	ATM-11	5426478805	TOW-19	5557777753	0.0	1685	614	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
391	SHL-21	5569277879	T62- 7	5433679254	6.7	2018	401	M+F KILL
[illegible]	SHL-21	5569277879	ATM-10	5443979191	6.7	1872	417	M+F KILL
438	SHL-21	5569277879	T62- 3	5448678950	6.7	1667	446	M KILL
454	SHL-21	5569277879	T62- 9	5402478822	0.0	1909	463	LOS LOST
456	T62- 5	5398878787	SHL-21	5569277879	[illegible]	1909	457	SURVIVE
461	T62- 9	54 2478822	SHL-21	5569277879	0.0	1909	462	M+F KILL
461	ATM-12	54 6[illegible]78857	SHL-21	5569277879	[illegible]	1909	470	PRV KILL
53[illegible]	TOW-19	5557777753	ATM-11	5412978962	5.0	1947	539	M KILL
535	DRG-23	5504478127	ICV-14	5486478663	0.0	537	541	ICV KILL
558	TOW-19	5557777753	T62- 2	5417178838	5.0	1802	566	M+F KILL
571	T62- 1	5425778755	TOW-19	5557777753	[illegible]	1654	572	SURVIVE
587	TOW-19	5557777753	T62- 8	5419378735	0.0	1685	595	M+F KILL
593	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	594	SURVIVE
593	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	594	SURVIVE
606	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	614	F KILL
614	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	615	SURVIVE
622	TOW-19	5557777753	ICV-15	5430078840	0.0	1685	630	SURVIVE
671	TOW-19	5557777753	ICV-15	5443978732	5.0	1568	678	ICV KILL
783	TOW-19	5557777753	ATM-12	5439378578	3.9	1477	790	SURVIVE
821	TOW-19	5557777753	ATM-12	5443878541	0.0	1390	828	M KILL
831	T62- 9	5440278506	TOW-19	5557777753	0.0	1390	832	SURVIVE
833	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	834	SURVIVE
839	TOW-19	5557777753	ICV-13	5447478576	[illegible]	1390	846	LOS LOST
844	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	845	M+F KILL
999	DRG-23	5504478127	ICV-13	5479078395	0.0	376	1003	ICV KILL
1015	DRG-23	5504478127	T62- 5	5473178264	3.6	321	1019	SURVIVE
1022	DRG-24	5495877972	T62- 9	5479378286	3.6	362	1026	M KILL
1042	DRG-24	5495877972	T62- 5	5483278213	3.6	321	1046	SURVIVE
1051	DRG-23	5504478127	T62- 5	5485778201	3.6	210	1054	SURVIVE
1059	DRG-24	5495877972	T62- 5	5488278188	3.6	284	1062	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
395	SHL-21	5569277879	ATM-1	5438979264	6.7	1989	404	M+F KILL
413	SHL-21	5569277879	ICV-14	5449379201	6.7	1843	421	ICV KILL
432	SHL-21	5569277879	T62- 9	5402478822	0.0	1968	441	M+F KILL
445	SHL-21	5569277879	T62- 5	5398878787	[illegible]	19[illegible]9	454	M+F KILL
453	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	454	SURVIVE
457	ATM-12	5406078857	SHL-21	5569277879	0.0	19[illegible]9	466	M+F KILL
480	TOW-19	5557777753	T62- 2	5393879107	5.0	2182	493	M+F KILL
516	TOW-19	5557777753	T62- 8	5401978937	5.0	2006	528	M+F KILL
542	TOW-19	5557777753	ATM-11	5416878918	5.0	1889	551	M KILL
565	TOW-19	5557777753	ICV-15	5426178885	5.0	1773	573	ICV KILL
571	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	572	SURVIVE
586	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	587	M+F KILL
596	TOW-19	5557777753	T62- 1	5425778755	[illegible]	1654	604	SURVIVE
6[illegible]8	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	609	SURVIVE
628	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	636	SURVIVE
639	T62- 1	5425778755	TOW-19	5557777753	[illegible]	1654	640	SURVIVE
660	TOW-19	5557777753	T62- 1	5425778755	[illegible]	1654	668	LOS LOST
661	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	662	M+F KILL
1001	DRG-23	5504478127	ICV-13	5479 78395	[illegible]	376	10[illegible]5	ICV KILL
1025	DRG-23	5504478127	ATM-12	5475478360	0.0	376	1029	SURVIVE
1029	ATM-12	5475478360	DRG-23	5504478127	0.0	376	1031	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
397	SHL-21	5569277879	ATM-10	5438979264	6.7	1960	406	M KILL
417	SHL-21	5569277879	ICV-14	5450979177	6.7	1814	425	ICV KILL
446	ATM-12	5406078857	SHL-21	5569277879	0.0	19 9	455	M+F KILL
45	SHL-21	5569277879	T62- 7	5457278911	0.0	1579	457	LOS LOST
529	DRG-23	55 4478127	T62- 3	5475678558	0.0	537	535	SURVIVE
534	T62- 7	5479278593	DRG-23	55 4478127	0.0	537	534	SURVIVE
538	DRG-24	5495877972	T62- 7	5479278593	.0	655	545	SURVIVE
539	TOW-19	5557777753	ATM-11	5414878940	5.0	1889	548	M KILL
545	T62- 3	5475678558	DRG-23	5504478127	0.0	537	545	M+F KILL
566	DRG-24	5495877972	T62- 7	5479278593	0.0	655	573	M+F KILL
567	TOW-19	5557777753	T62- 2	5420978793	5.0	1773	575	M+F KILL
572	T62- 3	5475678558	DRG-24	5495877972	0.0	655	572	SURVIVE
573	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	574	SURVIVE
587	TOW-19	5557777753	T62- 8	5419378735	0.0	1685	595	M+F KILL
588	DRG-24	5495877972	T62- 3	5475678558	0.0	655	595	SURVIVE
595	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	596	SURVIVE
596	T62- 3	5475678558	DRG-24	5495877972	0.0	655	596	SURVIVE
604	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	605	SURVIVE
607	T62- 3	5475678558	DRG-24	5495877972	0.0	655	6 7	SURVIVE
608	DRG-24	5495877972	T62- 3	5475678558	0.0	655	615	SURVIVE
611	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	619	SURVIVE
615	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	616	SURVIVE
62	T62- 3	5475678558	DRG-24	5495877972	0.0	655	620	M+F KILL
64	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	641	SURVIVE
647	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	655	M KILL
675	TOW-19	5557777753	ICV-15	5443978732	5.0	1539	682	SURVIVE
764	TOW-19	5557777753	T62- 3	5490278578	1.9	1101	768	SURVIVE
792	TOW-19	5557777753	T62- 3	5492778563	1.9	1048	796	SURVIVE
807	ATM-12	5443878541	TOW-19	5557777753	.0	1390	813	SURVIVE
808	T62- 5	5436678471	TOW-19	5557777753	.0	1390	8 9	SURVIVE

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
809	T62- 9	5440278506	TOW-19	5557777753	0.0	1390	810	SURVIVE
809	TOW-19	5557777753	ATM-12	5443878541	0.0	1390	816	M+F KILL
825	TOW-19	5557777753	ICV-13	5447478576	0.0	1390	832	ICV KILL
830	T62- 9	5440278506	TOW-19	5557777753	0.0	1390	831	SURVIVE
831	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	832	LOS LOST

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96   REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
412	SHL-21	5569277879	T62- 7	5442179131	6.7	1843	42[illegible]	SURVIVE
448	SHL-21	5569277879	T62- 7	5455678936	6.7	1579	455	SURVIVE
456	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	465	SURVIVE
460	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	461	SURVIVE
461	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	462	SURVIVE
47	ATM-12	54 6 78857	SHL-21	5569277879	0.0	1909	479	SURVIVE
471	SHL-21	5569277879	T62- 3	5462178754	0.0	1434	477	LOS LOST
481	T62- 9	5402478822	SHL-21	5569277879	[illegible]	19[illegible]9	482	SURVIVE
484	ATM-12	54 6[illegible]78857	SHL-21	5569277879	0.0	1909	493	M+F KILL
466	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	487	PRV KILL
467	SHL-21	5569277879	ATM-12	5406078857	0.0	1909	496	LOS LOST
492	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	493	PRV KILL
492	TOW-19	5557777753	ATM-11	54[illegible]1379[illegible]97	5.0	2123	504	M KILL
527	TOW-19	5557777753	T62- 2	54 747895[illegible]	5.0	1947	536	M+F KILL
533	DRG-23	55 4478127	ATM-1[illegible]	5482878628	[illegible].0	537	539	M KILL
543	T62- 7	5479278593	DRG-23	5504478127	[illegible]	537	543	M+F KILL
549	DRG-24	5495877972	T62- 7	5479278593	[illegible]	655	556	SURVIVE
553	TOW-19	5557777753	T62- 8	5411578826	5.0	183[illegible]	561	SURVIVE
567	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	568	SURVIVE
570	DRG-24	5495877972	T62- 7	5479278593	0.0	655	577	LOS LOST
575	T62- 3	5475678558	DRG-24	5495877972	0.0	655	575	M+F KILL
592	TOW-19	5557777753	T62- 8	5419378735	0.0	1685	600	F KILL
599	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	600	SURVIVE
6	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	601	SURVIVE
614	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	622	M+F KILL
621	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	622	SURVIVE
630	TOW-19	5557777753	ICV-1[illegible]	5430078840	0.0	1685	638	SURVIVE
667	TOW-19	5557777753	ICV-15	544167875[illegible]	5.0	1568	674	ICV KILL
776	TOW-19	5557777753	T62- 3	549[illegible]278578	1.9	1075	780	M+F KILL
795	TOW-19	5557777753	T62- 9	544[illegible]27859[illegible]6	0.0	1419	802	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
805	ATM-12	5443678541	TOW-19	5557777753	0.0	1390	811	SURVIVE
809	T62- 5	5436678471	TOW-19	5557777753	.0	1390	810	SURVIVE
816	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	822	SURVIVE
817	TOW-19	5557777753	T62- 5	5436678471	0.0	1390	824	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
4 1	SHL-21	5569277879	ATM-10	5440679239	6.7	1931	410	SURVIVE
426	SHL-21	5569277879	ATM-10	5450779093	6.7	1755	434	SURVIVE
453	SHL-21	5569277879	ATM-1	5462578922	6.7	1550	460	M KILL
457	T62- 9	54 2478822	SHL-21	5569277879	0.0	1909	458	SURVIVE
458	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	459	SURVIVE
464	SHL-21	5569277879	T62- 7	5462378838	6.7	1463	470	M+F KILL
464	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	473	LOS LOST
469	T62- 5	5398878787	SHL-21	5569277879	0.0	19 9	47	F KILL
499	TOW-19	5557777753	ATM-11	5403279074	5.0	2093	511	M KILL
527	TOW-19	5557777753	T62- 2	54 747895	5.0	1947	536	M+F KILL
536	DRG-23	55 4478127	ICV-14	5486478663	0.0	537	542	ICV KILL
55	TOW-19	5557777753	T62- 8	5411578826	5.0	1860	559	SURVIVE
586	T62- 1	5425778755	TOW-19	5557777753	.0	1654	587	SURVIVE
597	TOW-19	5557777753	T62- 8	5419378735	0.0	1685	605	M+F KILL
604	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	605	SURVIVE
613	T62- 1	5425778755	TOW-19	5557777753	0.0	1654	614	M+F KILL
621	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	622	SURVIVE
645	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	646	SURVIVE
657	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	658	SURVIVE
68	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	681	SURVIVE
699	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	700	SURVIVE
713	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	714	SURVIVE
713	DRG-24	5495877972	T62- 3	5480578572	1.9	659	722	SURVIVE
729	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	730	M+F KILL
874	DRG-23	55 4478127	ICV-15	5486178408	0.0	359	878	ICV KILL
998	DRG-23	55 4478127	ICV-13	5479078395	0.0	376	1002	ICV KILL
1 5	ATM-12	5475478360	DRG-23	5504478127	0.0	376	1007	SURVIVE
1 12	ATM-12	5475478360	DRG-23	5504478127	0.0	376	1014	SURVIVE
1 15	DRG-23	5504478127	T62- 9	5476778299	3.6	321	1019	M+F KILL
1 19	ATM-12	5475478360	DRG-23	5504478127	0.0	376	1021	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
1021	T62- 1	5425778755	DRG-23	5504478127	0.0	1004	1022	PRV KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
403	SHL-21	5569277879	ATM-10	5442379215	6.7	1931	412	SURVIVE
433	SHL-21	5569277879	ATM-10	5454179044	6.7	1697	441	M+F KILL
450	SHL-21	5569277879	T62- 7	5457278911	6.7	1579	457	SURVIVE
452	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	461	SURVIVE
459	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	460	SURVIVE
463	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	464	SURVIVE
466	SHL-21	5569277879	ATM-12	5406078857	0.0	1909	475	M+F KILL
466	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	475	LOS LOST
481	SHL-21	5569277879	T62- 9	5402478822	0.0	1909	490	SURVIVE
483	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	484	SURVIVE
5[illegible]	T62- 9	54 2478822	SHL-21	5569277879	0.0	1909	501	SURVIVE
5	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	501	SURVIVE
503	TOW-19	5557777753	T62- 2	5401679016	5.0	2065	515	M+F KILL
507	SHL-21	5569277879	T62- 9	5402478822	0.0	1909	516	M+F KILL
516	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	517	SURVIVE
522	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	523	SURVIVE
523	SHL-21	5569277879	T62- 7	5479278593	0.0	1146	528	M+F KILL
527	DRG-23	5504478127	T62- 3	5475678558	0.0	537	533	M+F KILL
528	TOW-19	5557777753	T62- 8	5403878915	5.0	1947	537	M+F KILL
534	SHL-21	5569277879	T62- 5	5398878787	0.0	1909	543	M+F KILL
554	DRG-24	5495877972	ICV-14	5486478663	0.0	655	561	ICV KILL
564	SHL-21	5569277879	T62- 1	5425778755	0.0	1676	572	SURVIVE
577	T62- 1	5425778755	SHL-21	5569277879	0.0	1676	578	SURVIVE
580	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	588	M+F KILL
588	T62- 1	5425778755	SHL-21	5569277879	0.0	1676	589	SURVIVE
586	ATM-11	5426478805	TOW-19	5557777753	0.0	1685	596	M+F KILL
6	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	608	SURVIVE
611	SHL-21	5569277879	ICV-15	5430078840	0.0	1707	619	ICV KILL
616	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	624	LOS LOST
874	DRG-23	5504478127	ATM-11	5482578374	0.0	359	878	SURVIVE

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
883	ATM-11	5482578374	DRG-23	5504478127	[illegible]	33[illegible]	885	M+F KILL
1116	DRG-24	5495877972	ICV-13	5496478305	3.9	3[illegible]1	1119	ICV KILL
1122	ATM-11	5506978204	DRG-24	5495877972	0.0	233	1124	SURVIVE
1129	ATM-11	55 69782 4	DRG-24	5495877972	0.0	233	1131	M+F KILL
1129	DRG-24	5495877972	ATM-11	55[illegible]69782[illegible]4	0.0	233	1132	LOS LOST

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 1)

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
403	SHL-21	5569277879	ATM-10	5442379215	6.7	1931	412	M KILL
423	SHL-21	5569277879	T62- 1	5386879274	0.0	2350	435	LOS LOST
447	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	456	SURVIVE
451	SHL-21	5569277879	ICV-14	5464478981	6.7	1579	458	ICV KILL
457	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	458	SURVIVE
457	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	458	SURVIVE
461	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	470	SURVIVE
462	SHL-21	5569277879	ATM-12	5406078857	0.0	1909	471	M+F KILL
474	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	475	SURVIVE
478	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	479	SURVIVE
478	SHL-21	5569277879	T62- 2	5392079129	5.0	2222	489	SURVIVE
491	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	492	SURVIVE
499	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	500	SURVIVE
517	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	518	SURVIVE
525	SHL-21	5569277879	T62- 2	5407478950	5.0	1992	534	M+F KILL
528	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	529	SURVIVE
534	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	535	SURVIVE
534	TOW-19	5557777753	ATM-11	5412978962	5.0	1919	543	SURVIVE
539	SHL-21	5569277879	T62- 7	5479278593	0.0	1146	544	M+F KILL
544	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	545	SURVIVE
55[illegible]	SHL-21	5569277879	T62- 3	5475678558	0.0	1146	555	M+F KILL
560	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	561	SURVIVE
562	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	563	SURVIVE
563	SHL-21	5569277879	T62- 8	5415478781	5.0	1792	571	SURVIVE
567	TOW-19	5557777753	ATM-11	5424578828	5.0	1773	575	M KILL
570	T62- 1	5425778755	SHL-21	5569277879	0.0	1676	571	SURVIVE
576	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	577	SURVIVE
585	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	586	SURVIVE
589	T62- 1	5425778755	SHL-21	5569277879	[illegible]	1676	590	M+F KILL
597	T62- 8	5419378735	TOW-19	5557777753		1685	598	M+F KILL

Table E-II-2a

FIRING DATA FROM IUA TRIAL 96 BASE CASE

IUA TRIAL 96 REP 10

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
61	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	611	SURVIVE
621	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	622	SURVIVE
637	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	638	SURVIVE
649	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	650	SURVIVE
663	T62- 1	5425778755	DRG-24	5495877972	[illegible]	1052	664	SURVIVE
686	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	687	SURVIVE
689	DRG-24	5495877972	ICV-15	5453878678	5.0	881	697	SURVIVE
714	DRG-24	5495877972	ICV-15	545317866	[illegible]	796	722	SURVIVE
715	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	716	SURVIVE
723	T62- 8	5442478555	DRG-24	5495877972	0.0	796	723	M+F KILL
874	DRG-23	55 4478127	T62- 8	54753783 4	5.0	359	878	SURVIVE
896	DRG-23	55 4478127	T62- 8	5482078248	5.0	243	899	SURVIVE
9.6	T62- 1	5425778755	DRG-23	5504478127	0.0	1004	907	SURVIVE
917	T62- 1	5425778755	DRG-23	5504478127	0.0	1004	918	SURVIVE
922	DRG-23	55 4478127	T62- 8	5491078173	5.0	127	924	SURVIVE
94	T62- 1	5425778755	DRG-23	5504478127	0.0	1004	941	SURVIVE

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 95E REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
541	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	542	SURVIVE
553	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	554	SURVIVE
562	SHL-21	5569277879	T62- 1	5425778755	0.0	1676	570	F KILL
563	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	571	LOS LOST
567	T62- 9	54 2673822	SHL-21	5569277879	0.0	1909	568	SURVIVE
568	T62- 3	5475678558	SHL-21	5569277879	0.0	1146	569	SURVIVE
572	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	573	SURVIVE
574	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	575	SURVIVE
574	SHL-21	5569277879	T62- 7	5479278593	0.0	1146	579	M+F KILL
579	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	588	SURVIVE
586	SHL-21	5569277879	T62- 3	5475678558	0.0	1146	591	M+F KILL
59	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	591	SURVIVE
593	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	602	M+F KILL
594	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	602	PRV KILL
595	T62- 8	5419378735	SHL-21	5569277879	0.0	1707	596	PRV KILL
596	T62- 2	5422878770	TOW-19	5557777753	0.0	1685	597	SURVIVE
600	SHL-21	5569277879	T62- 9	5402478822	0.0	1909	609	LOS LOST
601	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	602	PRV KILL
602	TOW-19	5557777753	ATM-11	5426478805	0.0	1685	610	M KILL
613	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	614	SURVIVE
620	T62- 2	5422878770	TOW-19	5557777753	0.0	1685	621	SURVIVE
625	TOW-19	5557777753	ICV-15	5430078840	0.0	1685	633	ICV KILL
629	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	630	SURVIVE
636	T62- 2	5422878770	TOW-19	5557777753	0.0	1685	637	SURVIVE
642	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	643	SURVIVE
645	TOW-19	5557777753	T62- 2	5425278752	5.0	1685	653	M+F KILL
669	TOW-19	5557777753	T62- 8	5430878645	5.0	1568	676	SURVIVE
763	TOW-19	5557777753	ATM-10	5494878662	1.9	1101	767	M+F KILL
788	TOW-19	5557777753	ATM-12	5441578560	3.9	1448	795	M+F KILL
802	TOW-19	5557777753	T62- 5	5436678471	0.0	1390	809	M+F KILL

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 95E REP 1

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
8[illegible]7	T62- 9	544 2785 6	TOW-19	5557777753	0.0	1390	808	SURVIVE
823	T62- 9	5440278506	TOW-19	5557777753	0.0	1390	824	SURVIVE
826	TOW-19	5557777753	ICV-13	5447478576	0.0	1390	833	ICV KILL
846	T62- 9	5440278506	TOW-19	5557777753	0.0	1390	847	SURVIVE
847	TOW-19	5557777753	T62- 9	544 2785 6	0.0	1390	854	M+F KILL
849	DRG-24	5495877972	T62- 8	5465878373	5.0	542	855	M+F KILL
1[illegible]81	DRG-24	5495877972	ICV-14	5530078470	1.9	530	1087	ICV KILL

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
539	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	540	M+F KILL
543	SHL-21	5569277879	T62- 1	5425778755	0.0	1676	551	M+F KILL
55[illegible]	T62- 3	5475678558	SHL-21	5569277879	0.0	1146	551	SURVIVE
553	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	554	SURVIVE
563	T62- 3	5475678558	SHL-21	5569277879	0.0	1146	564	SURVIVE
566	DRG-23	55 4478127	T62- 3	5475678558	0.0	537	572	SURVIVE
576	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	577	SURVIVE
577	T62- 3	5475678558	SHL-21	5569277879	0.0	1146	578	SURVIVE
583	SHL-21	5569277879	T62- 7	5479278593	0.0	1146	588	M+F KILL
586	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	596	SURVIVE
588	ATM-12	54[illegible]6[illegible]78857	SHL-21	5569277879	0.0	1909	597	M+F KILL
59[illegible]	T62- 2	5422878770	SHL-21	5569277879	0.0	1707	591	PRV KILL
591	DRG-23	55[illegible]4478127	T62- 3	5475678558	0.0	537	597	M+F KILL
593	T62- 3	5475678558	SHL-21	5569277879	0.0	1146	594	PRV KILL
594	T62- 8	5419378735	SHL-21	5569277879	0.0	1707	595	PRV KILL
611	T62- 2	5422878770	DRG-23	5504478127	0.0	1035	612	SURVIVE
625	TOW-19	5557777753	T62- 2	5422878770	0.0	1685	633	SURVIVE
631	T62- 2	5422878770	DRG-23	5504478127	0.0	1035	632	SURVIVE
631	T62- 8	5419378735	DRG-23	5504478127	0.0	1035	632	SURVIVE
631	ATM-11	5426478805	TOW-19	5557777753	0.0	1685	639	SURVIVE
642	T62- 8	5419378735	DRG-23	5504478127	0.0	1035	643	SURVIVE
644	ATM-11	5428778787	TOW-19	5557777753	0.0	1685	652	SURVIVE
655	T62- 2	5427578734	DRG-23	5504478127	0.0	1035	656	SURVIVE
657	TOW-19	5557777753	T62- 2	5429878716	5.0	1627	664	SURVIVE
673	TOW-19	5557777753	ATM-11	5440378697	5.0	1539	680	SURVIVE
781	TOW-19	5557777753	ATM-10	5499978633	1.9	1075	785	SURVIVE
8[illegible]5	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	811	SURVIVE
814	T62- 9	544[illegible]278536	TOW-19	5557777753	0.0	1390	815	SURVIVE
818	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	819	SURVIVE
821	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	827	M+F KILL

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 2

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
827	T62- 9	544 278506	TOW-19	5557777753	0.0	1390	828	PRV KILL
892	ATM-11	5482578374	DRG-23	5504478127	0.0	330	894	M+F KILL

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
533	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	534	SURVIVE
546	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	547	SURVIVE
557	SHL-21	5569277879	T62- 1	5425778755	0.0	1576	565	M+F KILL
562	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	563	SURVIVE
567	ATM-12	54 6 78857	SHL-21	5569277879	0.0	1909	575	SURVIVE
571	T62- 3	5475678558	SHL-21	5569277879	0.0	1146	572	SURVIVE
579	SHL-21	5569277879	ATM-12	5406078857	0.0	1909	588	M KILL
583	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	592	LOS LOST
585	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	586	SURVIVE
586	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	587	SURVIVE
596	SHL-21	5569277879	T62- 7	5479278593	0.0	1146	601	M+F KILL
599	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	600	SURVIVE
601	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	609	SURVIVE
602	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	603	SURVIVE
604	T62- 3	5475678558	SHL-21	5569277879	0.0	1146	605	SURVIVE
607	SHL-21	5569277879	T62- 3	5475678558	0.0	1146	612	M+F KILL
612	DRG-24	5495877972	T62- 3	5475678558	0.0	655	619	PRV KILL
613	T62- 8	5419378735	SHL-21	5569277879	0.0	1707	614	SURVIVE
614	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	622	SURVIVE
615	T62- 2	5422878777	SHL-21	5569277879	0.0	1707	616	M KILL
616	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	617	SURVIVE
621	SHL-21	5569277879	T62- 9	5402478822	0.0	1909	630	SURVIVE
625	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	635	LOS LOST
630	T62- 8	5419378735	SHL-21	5569277879	0.0	1707	631	M+F KILL
638	TOW-19	5557777753	T62- 2	5422878777	4.4	1685	646	SURVIVE
644	ATM-11	5428778787	TOW-19	5557777753	0.0	1685	652	M+F KILL
647	T62- 8	5421678717	TOW-19	5557777753	0.0	1685	648	PRV KILL
836	ATM-10	5507578590	DRG-24	5495877972	0.0	618	839	SURVIVE
836	DRG-24	5495877972	ATM-11	5468278477	5.0	596	843	M+F KILL
844	ATM-10	5507578590	DRG-24	5495877972	0.0	618	847	SURVIVE

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 3

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
852	AT4-10	55 757859.	DRG-24	5495877972	0.0	606	855	SURVIVE
857	DRG-24	5495877972	T62- 8	5463278356	5.0	515	863	F KILL
860	AT4-10	5507573590	DRG-24	5495877972	0.0	608	863	SURVIVE
868	AT4-10	5507578590	DRG-24	5495877972	0.0	608	871	M+F KILL
1003	DRG-23	5504478127	T62- 5	5470678277	3.9	376	1007	SURVIVE
1021	DRG-23	5504478127	T62- 5	5475778251	3.9	293	1024	SURVIVE

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 4

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
53	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	531	SURVIVE
537	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	545	M+F KILL
589	T62- 2	5422878770	TOW-19	5557777753	0.0	1685	590	SURVIVE
599	TOW-19	5557777753	T62- 2	5422878770	0.0	1685	607	M+F KILL
612	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	613	SURVIVE
619	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	620	SURVIVE
620	TOW-19	5557777753	T62- 8	5419378735	0.0	1685	628	F KILL
626	ATM-11	5426478305	TOW-19	5557777753	0.0	1685	634	SURVIVE
641	ATM-11	5428773787	TOW-19	5557777753	0.0	1685	649	SURVIVE
65	SHL-21	5569277379	ICV-15	5434678804	0.0	1678	658	LOS LOST
654	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	655	M+F KILL
662	TOW-19	5557777753	ATM-11	5435778733	5.0	1597	669	M KILL
662	TOW-19	5557777753	ICV-15	5445278714	0.0	1510	689	LOS LOST
769	TOW-19	5557777753	ATM-10	5497478648	1.9	1075	773	M+F KILL
782	TOW-19	5557777753	T62- 7	5496378598	1.9	1075	785	SURVIVE
8[illegible]6	T62- 9	544 27856	TOW-19	5557777753	0.0	1390	807	SURVIVE
806	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	812	SURVIVE
807	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	808	SURVIVE
810	TOW-19	5557777753	T62- 7	5501478569	0.0	1022	814	LOS LOST
817	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	823	M+F KILL
82	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	821	PRV KILL
835	DRG-24	5495877972	T62- 7	5506078538	2.2	606	842	SURVIVE
866	DRG-24	5495877972	T62- 7	5511278543	0.0	571	872	LOS LOST
891	DRG-24	5495877372	ICV-15	54861784[illegible]8	0.0	412	896	SURVIVE
919	DRG-24	5495877972	ICV-15	5486178408	0.0	412	924	ICV KILL
944	DRG-24	5495877972	T62- 7	5524978383	0.0	530	950	M+F KILL
955	T62- 3	5521378348	DRG-24	5495877972	0.0	527	955	SURVIVE
959	DRG-24	5495877972	T62- 3	5521378348	0.0	527	965	SURVIVE
1007	DRG-23	55[illegible]4478127	ICV-13	5479078395	0.0	376	1011	ICV KILL
1013	ATM-12	5475478360	DRG-23	5504478127	0.0	376	1015	M+F KILL

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
454	SHL-21	5569277879	ATM-12	5405078857	0.0	1909	463	M KILL
462	T62- 9	54 2478822	SHL-21	5569277879	0.0	1909	463	SURVIVE
468	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	469	SURVIVE
471	SHL-21	5569277879	ICV-13	5409678892	0.0	1909	480	SURVIVE
473	T62- 9	54 2478822	SHL-21	5569277879	0.0	19 9	474	SURVIVE
487	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	488	SURVIVE
49	T62- 9	54 2478822	SHL-21	5569277879	0.0	1909	491	SURVIVE
494	SHL-21	5569277879	T62- 9	5412478822	0.0	1909	503	M+F KILL
499	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	500	SURVIVE
510	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	511	SURVIVE
518	SHL-21	5569277879	T62- 5	5398878787	0.0	1909	527	M+F KILL
522	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	523	SURVIVE
538	T62- 1	5425778755	SHL-21	5569277879	0.0	1676	539	SURVIVE
539	SHL-21	5569277879	ICV-13	5409678892	0.0	1909	548	ICV KILL
556	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	564	SURVIVE
559	T62- 1	5425778755	SHL-21	5569277879	0.0	1676	560	SURVIVE
564	SHL-21	5569277879	T62- 1	5425778755	0.0	1676	572	SURVIVE
581	T62- 1	5425778755	SHL-21	5569277879	0.0	1676	582	SURVIVE
586	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	595	SURVIVE
588	ATM-11	5426478805	TOW-19	5557777753	0.0	1685	596	M+F KILL
592	T62- 2	542287877	SHL-21	5569277879	0.0	1707	593	SURVIVE
596	SHL-21	5569277879	T62- 1	5425778755	0.0	1676	604	SURVIVE
601	T62- 8	5419378735	SHL-21	5569277879	0.0	1707	602	M KILL
603	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	611	SURVIVE
606	T62- 2	5422878770	SHL-21	5569277879	0.0	1707	607	SURVIVE
608	T62- 1	5425778755	SHL-21	5569277879	0.0	1676	609	SURVIVE
612	T62- 8	5419378735	SHL-21	5569277879	0.0	1707	613	SURVIVE
617	T62- 2	542287877	SHL-21	5569277879	0.0	1707	618	SURVIVE
617	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	625	M+F KILL
623	T62- 1	5425778755	SHL-21	5569277879	0.0	1676	624	PRV KILL

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 5

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
650	T52- 1	5425778755	DRG-24	5495877972	0.0	1052	651	SURVIVE
670	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	671	SURVIVE
685	T52- 1	5425778755	DRG-24	5495877972	0.0	1052	686	SURVIVE
696	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	697	SURVIVE
729	T52- 1	5425778755	DRG-24	5495877972	0.0	1052	730	SURVIVE
747	T52- 1	5425778755	DRG-24	5495877972	0.0	1052	748	SURVIVE
767	T52- 1	5425778755	DRG-24	5495877972	0.0	1052	768	SURVIVE
784	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	785	SURVIVE
785	DRG-24	5495877972	T62- 7	5496378598	1.9	643	792	SURVIVE
8[illegible]	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	801	SURVIVE
82	DRG-24	5495877972	T62- 7	5501478569	1.9	616	827	SURVIVE
825	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	826	SURVIVE
835	ATM-1	55 757853[illegible]	DRG-24	5495877972	0.0	608	838	SURVIVE
843	ATM-10	5507578590	DRG-24	5495877972	.0	606	846	SURVIVE
851	T52- 1	5425778755	DRG-24	5495877972	0.0	1052	852	SURVIVE
852	DRG-24	5495877972	T62- 7	5508178520	0.0	582	858	LOS LOST
855	ATM-1[illegible]	55[illegible]757859[illegible]	DRG-24	5495877972	0.0	608	858	SURVIVE
863	ATM-10	5507578590	DRG-24	5495877972	0.0	608	866	M+F KILL

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 6

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
535	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	536	M+F KILL
542	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	550	M+F KILL
771	TOW-19	5557777753	T62- 7	5493878613	1.9	1075	775	SURVIVE
799	TOW-19	5557777753	T62- 7	5493978584	0.0	1022	803	LOS LOST
803	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	809	SURVIVE
811	T62- 9	5440278506	TOW-19	5557777753	0.0	1390	812	SURVIVE
815	ATM-12	5443678541	TOW-19	5557777753	0.0	1390	821	SURVIVE
817	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	818	SURVIVE
822	TOW-19	5557777753	ATM-12	5443878541	0.0	1390	829	M KILL
825	T62- 9	5440278506	TOW-19	5557777753	0.0	1390	826	SURVIVE
827	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	833	LOS LOST
830	SHL-21	5569277879	T62- 9	5440278506	0.0	1426	836	M+F KILL
834	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	835	SURVIVE
842	TOW-19	5557777753	T62- 5	5436678471	0.0	1390	849	SURVIVE
859	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	860	SURVIVE
861	SHL-21	5569277879	ATM-11	5475378425	5.0	1093	865	M KILL
872	SHL-21	5569277879	T62- 8	5472978321	5.0	1034	875	F KILL
873	TOW-19	5557777753	T62- 5	5436678471	0.0	1390	880	M+F KILL
881	DRG-23	5504478127	T62- 2	5481178327	5.0	330	885	SURVIVE
892	TOW-19	5557777753	ICV-13	5447478576	0.0	1390	899	SURVIVE
897	SHL-21	5569277879	ICV-15	5486178408	0.0	1005	901	ICV KILL
899	DRG-23	5504478127	T62- 2	5487978264	5.0	243	902	SURVIVE
912	SHL-21	5569277879	T62- 2	5492378227	5.0	863	916	M+F KILL
915	DRG-23	5504478127	T62- 2	5492378227	0.0	156	917	PRV KILL
92[illegible]	SHL-21	5569277879	ICV-13	5447378548	5.0	1426	926	ICV KILL
933	SHL-21	5569277879	T62- 7	5522678400	2.2	726	936	M+F KILL
948	SHL-21	5569277879	T62- 3	5521378348	0.0	672	951	M+F KILL
1080	SHL-21	5569277879	ATM-10	5526478435	1.9	699	1083	M+F KILL
1092	SHL-21	5569277879	ICV-14	5532178452	5.3	672	1095	ICV KILL

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
534	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	535	SURVIVE
55	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	558	M+F KILL
551	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	552	SURVIVE
596	T62- 2	5422878770	TOW-19	5557777753	0.0	1685	597	M+F KILL
596	T62- 8	5419378735	TOW-19	5557777753	0.0	1685	597	PRV KILL
6 4	SHL-21	5569277879	T62- 2	5422878770	0.0	1707	612	M+F KILL
619	SHL-21	5569277879	T62- 8	5419378735	0.0	1707	627	M+F KILL
625	ATM-11	54264788 5	SHL-21	5569277879	0.0	1707	633	SURVIVE
627	T62- 9	54 2478822	SHL-21	5569277879	0.0	1909	628	SURVIVE
627	ATM-12	54 6 78857	SHL-21	5569277879	0.0	1909	635	M+F KILL
628	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	629	PRV KILL
634	SHL-21	5569277879	ATM-11	54264788 5	0.0	1707	642	LOS LOST
834	DRG-24	5495877972	T62- 7	5506078538	2.2	608	841	M KILL
836	ATM-1	55 757859	DRG-24	5495877972	0.0	608	839	SURVIVE
844	ATM-1	55 757859	DRG-24	5495877972	0.0	608	847	SURVIVE
847	DRG-24	5495877972	ATM-10	5507578590	0.0	608	854	SURVIVE
852	ATM-10	5507578590	DRG-24	5495877972	0.0	608	855	SURVIVE
860	ATM-10	5507578590	DRG-24	5495877972	0.0	608	863	SURVIVE
867	DRG-24	5495877972	ATM-1	550757859	0.0	608	874	M+F KILL
868	ATM-10	5507578590	DRG-24	5495877972	0.0	608	871	SURVIVE
884	ATM-11	5482578374	DRG-24	5495877972	0.0	412	885	SURVIVE
891	ATM-11	5482578374	DRG-24	5495877972	0.0	412	893	SURVIVE
895	DRG-24	5495877972	ICV-14	5511178625	0.0	608	902	SURVIVE
9 2	ATM-11	5482578374	DRG-24	5495877972	0.0	412	904	SURVIVE
909	ATM-11	5482578374	DRG-24	5495877972	0.0	412	911	SURVIVE
918	DRG-24	5495877972	ICV-14	5511178625	0.0	608	925	ICV KILL
919	ATM-11	5482578374	DRG-24	5495877972	0.0	412	921	SURVIVE
928	ATM-11	5482578374	DRG-24	5495877972	0.0	412	930	M+F KILL
1003	DRG-23	55 4478127	T62- 9	5474278312	3.9	376	1007	SURVIVE
1 6	ATM-11	55 4978187	DRG-23	5504478127	0.0	44	1006	SURVIVE

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 7

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
1009	ATM-12	5475478360	DRG-23	55 4478127	..	376	1:11	SURVIVE

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 8

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
618	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	626	LOS LOST
619	SHL-21	5569277579	T62- 1	5425778755	0.0	1676	627	M+F KILL
624	T62- 7	5479278593	SHL-21	5569277879	0.0	1146	625	SURVIVE
626	ATM-12	5406078857	SHL-21	5569277879	0.0	1909	635	M+F KILL
630	T62- 9	5402478822	SHL-21	5569277879	0.0	1909	631	PRV KILL
631	T62- 8	5419378735	SHL-21	5569277879	0.0	1707	632	PRV KILL
632	SHL-21	5569277879	T62- 3	5475678558	0.0	1146	637	LOS LOST
633	DRG-24	5495877972	T62- 7	5479278593	0.0	655	640	SURVIVE
634	ATM-11	5426478805	SHL-21	5569277879	0.0	1707	642	PRV KILL
653	DRG-24	5495877972	T62- 7	5479278593	0.0	655	660	F KILL
658	T62- 7	5479278593	DRG-24	5495877972	0.0	655	658	SURVIVE
658	T62- 3	5475678558	DRG-24	5495877972	0.0	655	658	SURVIVE
669	DRG-23	5504478127	T62- 2	5435778662	0.0	918	678	LOS LOST
672	T62- 3	5475678558	DRG-24	5495877972	0.0	655	672	SURVIVE
676	DRG-24	5495877972	T62- 3	5475678558	0.0	655	683	M+F KILL
682	T62- 3	5475678558	DRG-24	5495877972	0.0	655	682	SURVIVE
705	ATM-11	5449578625	DRG-24	5495877972	0.0	796	712	SURVIVE
712	T62- 2	5446078590	DRG-24	5495877972	0.0	796	712	M+F KILL
867	ATM-11	5482578374	DRG-23	5504478127	0.0	330	889	SURVIVE
895	ATM-11	5482578374	DRG-23	5504478127	0.0	330	897	SURVIVE
905	ATM-11	5482578374	DRG-23	5504478127	0.0	330	907	SURVIVE
912	ATM-11	5482578374	DRG-23	5504478127	0.0	330	914	SURVIVE
919	ATM-11	5482578374	DRG-23	5504478127	0.0	330	921	SURVIVE
928	ATM-11	5482578374	DRG-23	5504478127	0.0	330	930	SURVIVE
935	ATM-11	5482578374	DRG-23	5504478127	0.0	330	937	SURVIVE
943	ATM-11	5484773355	DRG-23	5504478127	0.0	330	945	SURVIVE

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 95E REP 9

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
538	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	539	SURVIVE
541	SHL-21	5569277879	T62- 1	5425778755	0.0	1676	549	M+F KILL
545	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	546	SURVIVE
547	TOW-19	5557777753	T62- 1	5425778755	0.0	1654	555	PRV KILL
548	T62- 9	54 2478822	SHL-21	5569277879	0.0	1909	549	SURVIVE
549	ATM-12	54 6078957	SHL-21	5569277879	0.0	1909	558	SURVIVE
561	SHL-21	5569277879	T62- 9	5402478822	0.0	1909	570	M+F KILL
563	ATM-12	5406078357	SHL-21	5569277879	0.0	1909	572	M+F KILL
566	T62- 9	54 2478822	SHL-21	5569277879	0.0	1909	567	PRV KILL
569	T62- 5	5398878787	SHL-21	5569277879	0.0	1909	570	PRV KILL
775	TOW-19	5557777753	ATM-11	5497478648	1.9	1075	779	M KILL
785	DRG-24	5495877972	T62- 7	5496378598	1.9	643	792	SURVIVE
791	TOW-19	5557777753	T62- 3	5492778563	1.9	1048	795	SURVIVE
806	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	807	SURVIVE
807	ATM-12	5443878541	TOW-19	5557777753	0.0	1390	813	M+F KILL
81[illegible]	DRG-24	5495877972	T62- 7	5501478569	1.9	630	817	M+F KILL
833	DRG-24	5495877972	T62- 3	5502478503	2.2	608	840	M+F KILL
859	DRG-24	5495877972	ATM-11	5475378425	5.0	515	865	M+F KILL
882	DRG-23	55 4478127	T62- 2	548117832	5.0	330	886	SURVIVE
887	DRG-24	5495877972	T62- 8	5479878266	5.0	367	891	SURVIVE
899	DRG-23	5504478127	T62- 2	5487978264	5.0	243	902	SURVIVE
916	DRG-23	5504478127	T62- 2	5492378227	5.0	156	918	SURVIVE
929	DRG-24	5495877972	T62- 8	5495578136	5.0	236	932	SURVIVE
947	DRG-23	5504478127	ICV-15	5488378390	0.0	301	950	LOS LOST

Table E-II-2b

FIRING DATA FROM IUA TRIAL 96 EXCURSION

IUA TRIAL 96E REP 10

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
463	SHL-21	5569277879	ATM-12	5406078857	0.0	1909	472	M+F KILL
479	SHL-21	5569277879	ICV-13	5409678892	0.0	1909	488	LOS LOST
486	T62- 9	54[illegible]2478822	SHL-21	5569277879	0.0	1909	487	M+F KILL
535	T62- 1	5425778755	DRG-24	5495877972	0.0	1052	536	M+F KILL
552	TOW-19	5557777753	T62- 1	5425778755	[illegible]	1654	560	M+F KILL
765	TOW-19	5557777753	ATM-1[illegible]	5497478648	1.9	11[illegible]1	769	SURVIVE
798	TOW-19	5557777753	ATM-10	5502478619	0.0	1022	802	LOS LOST
812	TOW-19	5557777753	T62- 9	5440278506	0.0	1390	819	M+F KILL
839	TOW-19	5557777753	T62- 5	5436678471	0.0	1390	845	M+F KILL
845	T62- 5	5436678471	TOW-19	5557777753	0.0	1390	846	SURVIVE
854	TOW-19	5557777753	ICV-13	5447478576	0.0	1390	861	ICV KILL
880	DRG-23	5504478127	ATM-11	5482578374	0.0	330	884	M KILL
895	DRG-23	5504478127	T62- 2	5485678283	5.0	272	898	SURVIVE
911	DRG-23	55[illegible]4478127	T62- 2	549[illegible]178245	5.0	185	913	M+F KILL
922	DRG-23	55[illegible]4478127	T62- 8	5491078173	5.0	127	924	SURVIVE

Table E-II-3

FIRING DATA FROM TETAM PHASE III FIELD TRIAL 96

CDEC TRIAL 96

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
416	TOW-13	5556677723	T62- 8	5379579295	4.9	2378	427	M+F KILL
461	SHL-21	5569277879	ATM-11	5396878333	5.5	2057	471	M KILL
476	T62- 1	5392879174	SHL-21	5569277879	0.0	2154	472	SURVIVE
498	SHL-21	5569277879	T62- 2	5418078837	6.1	1753	507	M+F KILL
502	T62- 3	5412478754	0	0 0	0.0	-0	0	UNPAIRED
508	T62- 2	5418278884	0	0 0	0.0	-0	0	UNPAIRED
511	ATM-12	5410378734	SHL-21	5569277879	0.0	1822	523	SURVIVE
516	TOW-19	5556577729	T62- 1	5417278914	6.4	1859	524	SURVIVE
525	T62- 5	5413678754	0	0 0	0.0	-0	0	UNPAIRED
543	ATM-12	5411478733	SHL-21	5569277879	0.0	1823	560	SURVIVE
559	TOW-19	5556577729	T62- 1	5426478801	5.1	1588	567	M+F KILL
559	DRG-23	5500578093	ICV-15	5443978695	5.1	777	569	SURVIVE
563	T62- 2	5424578786	0	0 0	0.0	-0	0	UNPAIRED
575	T62- 3	5419578731	0	0 0	0.0	-0	0	UNPAIRED
587	SHL-21	5569277879	T62- 1	5428373754	4.2	1658	595	PRV KILL
594	DRG-23	5500573093	T62- 1	5428578759	1.3	979	606	PRV KILL
605	ATM-12	5412378796	SHL-21	5569277879	0.0	1820	620	LOS LOST
630	T62- 5	5424178656	0	0 0	0.0	-0	0	UNPAIRED
635	T62- 9	5442178516	0	0 0	0.0	-0	0	UNPAIRED
642	T62- 3	5433773694	DRG-24	5435877974	0.0	793	643	SURVIVE
653	T62- 9	5442078514	0	0 0	0.0	-0	0	UNPAIRED
660	T62- 7	5480978612	0	0 0	0.0	-0	0	UNPAIRED
670	T62- 9	5442078513	0	0 0	0.0	-0	0	UNPAIRED
670	T62- 3	5460178673	DRG-24	5495877974	0.0	783	671	SURVIVE
676	ATM-10	5479778612	SHL-21	5569277879	0.0	1156	691	LOS LOST
682	T62- 7	5481578635	0	0 0	0.0	-0	0	UNPAIRED
688	SHL-21	5569277879	ATM-10	5479978613	2.8	1157	694	M KILL
692	T62- 9	5442078512	0	0 0	0.0	-0	0	UNPAIRED
693	ATM-12	5417278737	SHL-21	5569277879	0.0	1825	710	SURVIVE
701	T62- 3	5460178673	DRG-24	5495877974	0.0	732	702	SURVIVE

Table E-II-3

FIRING DATA FROM TETAM PHASE III FIELD TRIAL 96

CDEC TRIAL 96

FIRE TIME	FIRING WEAPON PLAYER	FIRING WEAPON LOCATION	TARGET WEAPON PLAYER	TARGET WEAPON LOCATION	VEL	RANGE (METERS)	IMPACT TIME	RESULT
705	T62- 9	5442078512	0	0 0	0.0	-0	0	UNPAIRED
711	ATM-10	5479378613	SHL-21	5569277879	0.0	1156	719	SURVIVE
715	T62- 3	5460178673	DRG-24	5495877974	0.0	792	716	SURVIVE
717	T62- 9	5442078512	0	0 0	0.0	-0	0	UNPAIRED
739	ATM-10	5479978614	SHL-21	5569277879	0.0	1156	752	LOS LOST
743	T62- 3	5460178673	DRG-24	5495877974	0.0	795	744	M+F KILL
745	T62- 9	5442078512	0	0 0	0.0	-0	0	UNPAIRED
753	SHL-21	5569277879	ATM-10	5479378614	0.0	1157	759	M KILL
760	T62- 9	5441978512	0	0 0	0.0	-0	0	UNPAIRED
780	DRG-23	5500578393	T62- 3	5460178674	0.0	705	789	M+F KILL
781	T62- 9	5442078510	0	0 0	0.0	-0	0	UNPAIRED
785	ATM-10	5479978614	SHL-21	5569277879	0.0	1153	793	SURVIVE
803	T62- 7	5437978615	0	0 0	0.0	-0	0	UNPAIRED
811	ATM-10	5479378614	SHL-21	5569277879	0.0	1159	819	SURVIVE
815	ATM-12	5421778689	SHL-21	5569277879	0.0	1683	826	M+F KILL
855	T62- 7	5507378562	0	0 0	0.0	-0	0	UNPAIRED
892	T62- 7	5511878535	0	0 0	0.0	-0	0	UNPAIRED
963	DRG-23	5500578093	T62- 9	5466978381	.5	426	969	SURVIVE
973	T62- 7	5532078338	0	0 0	0.5	-0	0	UNPAIRED
984	T62- 9	5468878371	DRG-23	5500578093	0.0	433	985	M+F KILL
996	T62- 9	5470378363	DRG-23	5500578093	0.5	435	997	PRV KILL
1001	TOW-19	5556677723	T62- 5	5485778257	3.4	942	1005	M+F KILL
1110	TOW-19	5556677729	T62- 9	5494078224	2.5	783	1114	M+F KILL

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The TETAM Model Verification study is reported in three volumes describing the validation of three high resolution combat simulation models (DYNTACS, IUA, and CARMONETTE) using field data collected by US Army Combat Developments Experimentation Command during Experiment 11.8. Volumes I and II contain an intervisibility study describing the abilities of the DYNTACS, IUA, and CARMONETTE terrain processors to predict line-of-sight occurrences between tanks and antitank missile positions. Volume III contains a validation study of the engagement processors of DYNTACS and IUA. The results

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20. from the simulation models in terms of firings, engagements, and losses between tank and antitank as compared with the field data collected during the free play battles of Field Experiment 11.8 are found in Volume III.

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